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1 Director’s Foreword

The IMA is about connections. Since its inception in 1982 it has vigorously fostered connections among mathematicians; connections between mathematicians and the users and potential users of mathematics in other sciences, engineering, and industry; connections between academics and scientists at industrial and government laboratories; connections between contemporary mathematical research and critical, complex problems arising in science, technology, and society.

The vision of the mathematical sciences as connected, central, and having a high impact on problems of general importance, is the vision that drove the establishment of the Institute for Mathematics and its Applications in 1982 and that continues to drive our activities today. In 1982, when the academic mathematics community was highly directed toward internally generated problems and communication lines were weak or broken, even between sub-disciplines of mathematics, this was a radical vision. But today, thanks in significant part to two decades of activity at the IMA, it has achieved much acceptance in the mathematical community and is spreading beyond. The IMA’s mission of fostering interdisciplinary collaborative mathematical research has by now been widely recognized as crucial—crucial to the vitality of mathematics, crucial to the progress of an increasing number of areas of science and engineering, and crucial to the health, prosperity, and security of our society.

The past year at the IMA, and especially our thematic program on Probability and Statistics in Complex Systems: Genomics, Networks, and Financial Engineering, brought us a little closer to realizing the vision. To many people, the human genome, the Internet, and the world financial markets would seem to have little in common. But in fact, there is much. First, each of these is a complex system. Complex in the ordinary sense of the word, and complex in the slightly more precise sense that they involve a very large number of interacting constituents whose cumulative nonlinear interactions lead to behaviors that we cannot predict simply by understanding the behaviors of the constituents parts. Second, modern technology allows us to gather and store huge amounts of data for each of these systems. Because of these attributes, the mathematical sciences can, in fact must, play a large role in the study of such systems. Huge amounts of mathematics has been developed to extract information from quantitative data, to find structures, patterns, anomalies, and trends in the data, to separate the random from the predictable, to extract the signal from the noise, to store, compute, and analyze. Much more mathematics needs to be developed, to handle the tremendous challenges posed by the massive data sets now available. In many case the same mathematics can, or will, help elucidate the genome, the Internet, and the markets.

But of course these systems are complex, in the ordinary sense of the word, and exhibit many differences. Scientists and engineers have learned much about their workings and behavior. Mathematicians and statisticians cannot expect to have a big impact working on their own. Major advances will require interdisciplinary research and collaboration. The IMA exists to foster such research and collaboration, and 2003–2004 saw over 1,000 mathematicians, statisticians, scientists, engineers, and social scientists come to the IMA to discuss, explore, explain, listen, and research. These efforts have already begun to bear fruit, but of course the larger impacts are still years off.

In this annual report we outline the major activities at the IMA over the past year, and also briefly report on some of the major impacts already realized from previous programs.
2 Overview of the IMA

IMA is a unique resource in applied mathematics. It has had a huge impact in promoting mathematics and its applications in the last 20 years.
– George Papanicolaou, Stanford University

2.1 The Mission of the IMA

The primary mission of the IMA is to foster research of a truly interdisciplinary nature, establishing links between mathematics of the highest caliber and important scientific and technological problems from other disciplines and industry. Allied with this mission, the IMA also aims to expand and strengthen the talent base engaged in mathematical research applied to or relevant to such problems.

2.2 IMA Strategies

The IMA pursues a variety of strategies to advance its mission.

• The IMA positions itself as an information hub in the mathematical sciences. It identifies important research areas and problems in need of new mathematics and communicates them to high quality mathematicians. It informs and instructs users and potential users about new mathematical developments. It brings together mathematicians and scientists to discuss important issues to whose resolution both groups may contribute.

The meeting was designed from the ground up to bring together numerical analysts, geometric analysts, and relativity physicists for a meaningful exchange of ideas. These quite separate research communities do not normally interact effectively due to a number of obstacles.
– Michael Holst, UCSD

This was one of the best workshops I have attended. It covered a good, broad range of topics yet was focused. Generally, people who develop models and people who are familiar with the possibilities for collecting data tend not to meet often enough, though both theory and data are needed to advance science.
– Alden Klovdahl, Australian National University

• The IMA provides a program and an environment which is highly conducive to research, collaboration, and communication.

I renewed several contacts, with Shmuel Friedland, Tom Kurtz, and Karen Ball. Made a new contact with Bryan Shader, as well as with Peter Olver of the UM Math Dept. Contact with Shmuel especially noteworthy, as he solved I problem had posed—within an hour!
– Robert B. Feinberg, NSA
I recently spent three weeks at IMA during the program on Probability and Statistics in Complex Systems. For me, my three weeks at IMA partly represented a time to meet with my collaborators on a grant, most of whom work on the West coast. Since I'm in Pennsylvania, I rarely get a chance to meet with them face-to-face. I found the time we all spent together at IMA to be very valuable and productive. IMA was a very gracious host, and by meeting at a place that was home to none of us we had uninterrupted time to do research. Several papers that were languishing in the pipeline have now been jump-started and are nearing completion, while several new papers were suggested by the work we did while at IMA.

One of my main collaborators on the grant was also the organizer of the workshop. Since IMA and its wonderful staff took care of all of the nitpicky logistical details associated with running a workshop, this collaborator was free to devote her energies to the research itself. Ultimately, my own experience at the workshop was enhanced by the fact that I and others were able to continue to work with her throughout the week of the workshop instead of having her attention diverted by her duties as organizer. – David Hunter, Penn State

• The IMA works to build lasting new multidisciplinary research communities.

A mathematical statistics problem on permutation analysis has been of great interest to me and I spoke about it at the Complex Systems Seminar on Oct 8, 2003. The problem intrigued visitors Greg Rempala and Karen Ball and we have been pursuing a solution since then. We have made good progress towards a solution and we continue to communicate about it since I’ve returned to Madison. The IMA’s commingling of mathematical scientists with diverse interests has in this case led to a fruitful collaboration which otherwise would not have happened.

– Michael Newton, University of Wisconsin at Madison

I was at an IMA meeting organized by Yali Amit in 2000. I met Laurent Younes there and we found that we had been working on the same problem from different ends. Decided to collaborate and the rest is history. We have the world’s first diffeomorphic point matching algorithm which will be presented at a meeting this summer and will hopefully show up in an archival form at some point. I’d like to thank Yali, IMA and the cosmos for helping to set up this connection. – Anand Rangarajan, University of Florida

• The IMA seeks out and meaningfully engages mathematicians and scientists from as wide as possible a variety of backgrounds, particularly considering groups which are traditionally underrepresented.

I was strongly encouraged when I saw so many girls and female mentors who are also working in Math. And I love those problems. If I had time I’d love to work on every one. – Mingfei Li, Michigan State University, who attended the May 2003 PIMS/IMA Graduate Student Mathematics Modeling Camp, and the subsequent problem solving workshop in Calgary
The IMA educates mathematicians at the start of their career and after they have been well-established. Its programs not only help mathematicians to extend their expertise, but also to broaden their perspective on the utility and impact of mathematics in science and technology. It enables them to become essential participants in interdisciplinary collaborations.

The focused atmosphere of IMA’s year long program on my research field (mathematics in multimedia) allowed me to broaden my perspective on this area to an extent that would not have been possible anywhere else. ... It was very rewarding to be exposed to such a concentration of expertise. Moreover, after my IMA experience I feel that my work has become more relevant to real applications.

– Selim Esedoglu, IMA Industrial Postdoctoral Member

The IMA enriches the education of the next generation of mathematical scientists by introducing graduate students to a wide view of the role of mathematics.

I really appreciated the access that IMA provides a graduate student such as myself to some of the most amazing research in industry. I feel fortunate that I was able to attend, and interact with the quality of participants that IMA consistently has drawn in many of its workshops which I’ve attended in the past.

– Pradyumna Upadrashta, University of Minnesota graduate student

2.3 Programmatic Mechanisms

The IMA conceives and executes a range of programs to implement its strategies.

• Annual Programs. Each year the IMA runs an annual thematic program lasting ten months and centered around an important area of application or investigation. These programs involve on the order of 1,000 participants including around 10 key senior visitors of three to ten months, six to eight postdocs selected for their interest in the program, and around 40 other visitors of a month or more. They are typically divided into a small number of periods of concentration in specific areas under the general theme, and include between six and twelve workshops of about one week duration, each involving 30–120 participants, and regular seminar series when workshops are not in progress. Tutorial lectures are an important part of most annual programs, and public lectures, panel discussions, and other activities may be as well. Annual programs require four to five years of advance planning and are organized in collaboration with a group of distinguished senior scientists.
IMA annual programs provide an opportunity to look at important areas of the mathematical sciences from a variety of perspectives. The fact that there are many forums (focused workshops, tutorials, continuing seminars, etc.) allows organizers to take risks in bringing together different groups of researchers who are not ordinarily in contact and to try different approaches to stimulate discussion and exchange of ideas. In particular, the programs provide a rich environment for the development of postdocs who may have concentrated on very narrow topics in completing their dissertations.
– Tom Kurtz, University of Wisconsin, lead organizer of the 2003–2004 thematic year

• **Summer Programs.** Each year the IMA runs a small number of summer programs lasting from two to seven weeks. These more intensive, more focused programs typically involve on the order of 100 participants. These require two to three years of advance planning and are organized in collaboration with a small group of excellent scientists.

I participated in the 2001 summer problem on “Geometric Methods in Inverse Problems and PDE Control”. I interacted for the first time with C. Croke, a differential geometer, and we have kept the communication ever since. We are working actively on a couple of projects. I think other participants of the summer school benefited as well, more specifically Slava Kurylev, Matti Lassas and Michael Taylor started their collaboration there that resulted in the beautiful paper “Boundary regularity for the Ricci equation, geometric convergence and Gel’fands inverse boundary problem”, to appear Invent. Math. – Gunther Uhlmann, University of Washington

• **Hot Topics and Special Workshops.** Each year the IMA runs a small number of workshops unrelated to its annual and summer programs. These can be organized in a matter of months and last from a few days to a week. Hot topics workshops focus on a specific problem or area of exceptional contemporary interest and importance, and are often cosponsored by one or more of our industrial partners. Other workshops have special aims, for example enhancing minority participation or facilitating communication between the math sciences community and funding agencies on specific issues.

I liked the creative and good atmosphere at the workshop very much. I made many new very good contacts and a new view of my problems was generated.
– Wolf Ketter, University of Minnesota, commenting on the 2003 Hot Topics workshop on Agent Based Modeling and Simulation

• **The IMA New Directions Program.** The New Directions program was inaugurated this year with the goal of partnering with established academic mathematicians to increase the impact of their research and enable them to direct their expertise and research activities in areas of significant application. The program consists of two major components: the New Directions Visiting Professorships, which enables established academic mathematicians to immerse themselves in the annual thematic program, learning new mathematics and applications, connecting their research with important problems, and establishing new contacts and collaborations; and the New Directions Short Courses, two-week intensive short course for mathematics faculty in an active and developing area of application.
• **New Directions Visiting Professorships.** These support established academic mathematicians to visit the IMA for a period of 9–12 months, immersing themselves in the IMA annual thematic program, learning new mathematics and applications, connecting their research with important problems, and establishing new contacts and collaborations. The first two New Directions professors, who spent the 2003–2004 academic year at the IMA, were Shmuel Friedland, Professor of Mathematics at University of Illinois at Chicago and Yuhong Yang, Associate Professor of Statistics at Iowa State University.

My visit to the IMA as a New Direction Visiting Professor has really been a wonderful experience for me. I benefited tremendously from the tutorials and workshops. The tutorials and workshops in bioinformatics were very informative and educational. They helped me to move from “zero” to being able to find research topics in this area, and the background knowledge resulted from the lectures has been instrumental for me to have begun conducting a rigorous research on analyzing gene expression data. Just this week, a student of mine, Minhui Paik, and I finished a paper on the use of nearest neighbor method for tumor classification based on micro-array data (Combining Nearest Neighbor Classifiers Versus Cross Validation Selection), which was submitted to “Statistical Applications in Genetics and Molecular Biology.” Without IMA, this would not have happened.

The academic atmosphere at IMA is superb. The various seminars and tea/coffee times provide lots of friendly opportunities for exchanges of academic ideas. As a result, I have been working with a long term visitor... we are now at the final stage of finishing the paper and we see several opportunities... after we finish the current paper.

– Yuhong Yang

• **New Directions Short Courses.** The second component of the IMA New Directions Program are the short courses. These two-week summer courses are designed to assist mature mathematical researchers to acquire the basic knowledge prerequisite to undertaking interdisciplinary research in a new field of application as efficiently and effectively as possible. The first such course, in mathematical cellular physiology, was offered in June 2003. For more information about this, see Section 3.6.
The course and the presented material was very interesting and I enjoyed the new directions short course very much. I have made many new contacts and got an impression of what is going on. The course’s impact is not only by the cell physiology we learned but also by the many “philosophical” comments made by the lecturers, which one would hardly find in any textbook. These are as valuable as any facts. I got insights into how research in mathematical biology is done, which is very useful for me.
– Wilhelm Huisinga, Free Institute, Berlin

• Industrial Mathematics Modeling Workshops for Graduate Students. Biamnually the IMA runs a workshop in which graduate students are exposed to industrial mathematical modeling, through the team solution and presentation of an industrial problem under the guidance of mentors from industry and the IMA mathematical community.

As a graduate student who attended the Industrial Math Modeling Workshop, I greatly enjoyed learning about non-academic career opportunities. It was especially interesting to realize how the flavor of research is influenced by industrial needs.
– Stephanie Hoogendoorn, University of Pittsburgh

• Participating Institution Summer Programs for Graduate Students. The IMA provides financial support and logistical assistance to our academic partner institutions for running an intensive program aimed at math graduate students each year.

• IMA Postdoctoral Program. Each year the IMA selects six to eight postdocs to spend one to two years in residence at the IMA and participate intensely in its programs. Postdocs are carefully mentored, and some are paired with industrial sponsors.

The IMA Postdoctoral Fellowship, that I held in 2001 - 2002, became a turning point of my career in science. It gave me a boost, both in terms of my research and in terms of my professional contacts. It was a great luck for me to get to IMA, and it is always a pleasure for me to express my sincere gratitude to IMA and to those Colleagues with whom I shared at IMA the joy of scientific quest and discovery.
– Michael Efroimisky, U.S. Naval Observatory

• Participating Institution Conferences. The IMA lends financial support and logistical assistance to our academic partner institutions in running conferences at their campuses. A few of these are supported each year.

• Seminar Series. Each year the IMA runs a variety of seminar series, such as one organized by and directed towards the IMA postdocs and another organized by and directed towards the long term visitors in residence. It also runs the Industrial Problems Seminar, with speakers coming from our industrial partners and local industries.

My skills to build and deliver research presentations were significantly improved by the weekly post-doctoral seminars and informal research talks at IMA. This was of major benefit during my interviews for an academic position.
– Dacian Daescu, former IMA Postdoc, Portland State University
• **Industrial Programs.** The IMA collaborates extensively with industrial scientists and corporations. This collaboration includes the Industrial Postdoctoral program where the postdocs devote half of their effort to industrial projects and work under the guidance of industry mentors. In addition, the IMA offers the Industrial Problems Seminar, a forum in which industry scientists present mathematical problems, and collaborates with industry on Hot Topics and special workshops.

• **Partnerships and Governance.** The IMA seeks the advice and the participation of a large cross section of the mathematical sciences community by forming partnerships with universities and corporations. Partners are involved directly in IMA planning activities, and participation of their members in IMA programs is facilitated. The IMA also involves various groups of experts, especially its Board of Governors, in the realization of its mission.

• **Various Outreach Activities.** The IMA engages in a variety of outreach activities. The directors visit industrial laboratories and meet with scientists and managers. They host visits from industrial scientists and managers to the IMA. They visit a variety of universities and meet with faculty and administrators. They reach out to other departments at the University of Minnesota. The 2004–2005 year will mark the formation of the Local Advisory Board, whose charge will be to increase awareness of the IMA at the University of Minnesota and nearby colleges. The IMA also sponsors occasional public lectures on mathematical topics of direct importance to the general public.

• **Dissemination and Communication.** The IMA maintains an extensive web space and has an extensive publication program to inform the scientific community of its activities and to disseminate the results of its programs.

2.4 **IMA Facilities**

The IMA is located in the heart of the University of Minnesota’s Minneapolis campus. Its main facilities are located primarily on the fourth floor of Lind Hall with additional offices on the second and third floors. The main conference area and some other functions are in two nearby buildings.

**Main Office Space.**

The main offices of the IMA cover 8,795 square feet in Lind Hall. We can accommodate 50 visitors there. Most who visit the IMA for more than one week are given offices to use during their stay, and many shorter term visitors are given offices as well. We have ten offices for directors, staff and computer systems. We have one conference room, one seminar room and two large open areas with 28 desks and workstations. This open area is also used for receptions and poster sessions during our workshops.

**Conference Area.** The nearby Electrical Engineering & Computer Science (EECS) building
houses the IMA’s main conference rooms. These two rooms consist of a 130 seat lecture hall and an adjoining reception area used for conference registration, between talk breaks and informal discussion, together comprising 2,268 square feet.

**Miscellaneous Space.** We have 1,886 square feet of offices in nearby Vincent Hall. We have one staff office for our technical typists and webmaster, one conference room and one seminar room. Vincent Hall also houses the School of Mathematics, the Mathematics Library and the offices of the Minnesota Center for Industrial Mathematics.

*The IMA provides extensive network and computer equipment for the use of all visitors.*

**Main Office Computer Facilities.** The IMA network consists of a combination of fiber-optic, copper based, and wireless media. The IMA internal network is connected by a 100 Mbit/s fiber-optic line to the University of Minnesota Backbone which is connected to the Internet 2 and GigaPOP links. We have total 115 workstations, most running Linux, but a few with other operating systems (Mac, Windows, SGI) available for special uses. In all, the IMA provides more than 91 networked seats, meaning that in most cases visitors have sole use of a host for the duration of their stay. Printing services are supplied by 15 networked laser printers, eight of which are public, so that both grayscale and color printing are easily available. The IMA’s computational servers (a Dual Alpha 21264 500MHz with 3.5 GB RAM Alpha Linux system, a Dual AMD MP1900+ with 3.5 GB RAM Linux system and a 4-processor Opteron 1.4 GHz 8.0 GB RAM linux system) provide substantial computational power for research. Also we have 22 servers to provide the usual printing, WWW, e-mail, Backup, and an account management services as well as high level of integration between the various supported platforms.

**Conference Room Computer Facilities.** The nearby EECS building houses the IMA’s main conference rooms. In 2002, we upgraded our projectors to phigh resolution LCD projectors. The lecture hall enjoys recently enhanced networking and multimedia capabilities which make it possible to project computer demonstrations, video onto two screens and also to record via five permanently mounted video cameras proceedings and broadcast them to the Internet. The enhanced networking includes a fiber-optic link in order to support the potentially very high bandwidth needs of multimedia presentations and the planned transmission of IMA conferences over the Internet.

**Wireless Internet Connection.** The IMA also provides a wireless connection to our visitors. Visitors can use their own wireless card, or they can borrow one from the IMA. This year, we have extended the IMA wireless network to include the nearby Radisson Hotel, used by most IMA visitors. We have over a dozen access points in Lind Hall, the EECS building and in the Radisson.

3 IMA Activities for 2003–2004

3.1 The 2003–2004 Program Year

The 2003–2004 program year encompassed the thematic program on Complex Systems, the summer program on “n-Categories: Foundations and Applications” and four hot topics workshops. The figures reported here are projections made in April 2004.

3.1.1 Statistical Data on the 2003–2004 Program Year
There were about 1,158 participant visits to the IMA by 1,033 distinct visitors during the program year. About 450 talks were delivered at the IMA and there were about 120 poster presentations. There were also 172 visits, by 166 visitors, to IMA planned activities that were held off-site.

The chart below shows the number of visitors in residence on any given day throughout the year. Note that there were rarely less than 35 visitors in attendance during this year.

The first table below shows the breakdown of visits by shorter to longer-term, and the second table shows the numbers of participants coming from IMA Participating Institutions and Participating Corporations, and from the University of Minnesota; the number of participants invited to give a presentation in their invitation and the number of participants offered funding in their invitation.

| Visitors in residence at the IMA during the 2003–2004 thematic program |

<table>
<thead>
<tr>
<th>Visits by length of stay.</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 1 week</td>
</tr>
<tr>
<td>1-2 weeks</td>
</tr>
<tr>
<td>2-4 weeks</td>
</tr>
<tr>
<td>1-6 months</td>
</tr>
<tr>
<td>more than 6 months</td>
</tr>
<tr>
<td>total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Some classes of participants.</th>
</tr>
</thead>
<tbody>
<tr>
<td>From IMA affiliates</td>
</tr>
<tr>
<td>from Participating Institutions</td>
</tr>
<tr>
<td>from Participating Corporations</td>
</tr>
<tr>
<td>From the University of Minnesota</td>
</tr>
<tr>
<td>Speakers</td>
</tr>
<tr>
<td>IMA funding</td>
</tr>
</tbody>
</table>

Of the visitors, 915 (79%) came from academic institutions, 178 (15%) from industry, and 65 (6%) from elsewhere (for example, national laboratories), almost the identical breakdown as last year. The department breakdown of the academic visitors is 502 (54%) from the mathematical sciences, 173 (19%) from computer science and electrical engineering, 126 (14%) from the life sciences, 82 (9%) from the business, economics, social sciences, 43 (4%) from other departments or unknown. These figures are illustrated in the pie charts below.
Visitors from academic, industrial, and other sectors; and departmental affiliations of academic visitors.

The final table shows the number of visits from groups traditionally underrepresented in mathematical sciences research.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>247</td>
</tr>
<tr>
<td>Black, non-Hispanic</td>
<td>23</td>
</tr>
<tr>
<td>Hispanic</td>
<td>43</td>
</tr>
</tbody>
</table>

Participants from underrepresented groups.

Graduate student statistics: During Complex Systems year there were 244 total visits by graduate students (51 visits from the University of Minnesota and 193 visits from other universities).
3.1.2 Personnel

**Long-term Visitors:** These are visitors who stay 20 days or more (and who are not postdocs or Minnesota mathematics faculty). They participate in the workshops, speak in seminars, and collaborate with other researchers, and contribute to and benefit from the program in a variety of ways. The following table lists the long-term visitors to the IMA in 2003–2004.

<table>
<thead>
<tr>
<th>Name</th>
<th>Home institution</th>
<th>Primary field</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soohan Ahn</td>
<td>Seoul National University (SRCCS)</td>
<td>Statistics</td>
<td>165</td>
</tr>
<tr>
<td>Hee-Jeong Baek</td>
<td>Seoul National University (BK 21 Math-SNU)</td>
<td>Mathematics</td>
<td>110</td>
</tr>
<tr>
<td>Peter Bank</td>
<td>Humboldt University of Berlin</td>
<td>Mathematics</td>
<td>41</td>
</tr>
<tr>
<td>Rene Carmona</td>
<td>Princeton University</td>
<td>OR and Financial Engineering</td>
<td>79</td>
</tr>
<tr>
<td>Laura Chihara</td>
<td>Carleton College</td>
<td>Mathematics and CS</td>
<td>122</td>
</tr>
<tr>
<td>Hi Jun Choe</td>
<td>Yonsei University</td>
<td>Mathematics</td>
<td>62</td>
</tr>
<tr>
<td>Wanyang Dai</td>
<td>Nanjing University</td>
<td>Mathematics</td>
<td>65</td>
</tr>
<tr>
<td>Hans Foellmer</td>
<td>Humboldt Universitat zu Berlin</td>
<td>Mathematics</td>
<td>92</td>
</tr>
<tr>
<td>Shmuel Friedland</td>
<td>University of Illinois - Chicago</td>
<td>Mathematics, Statistics and CS</td>
<td>302</td>
</tr>
<tr>
<td>Anne Gundel</td>
<td>Humboldt University Berlin</td>
<td>Mathematics</td>
<td>33</td>
</tr>
<tr>
<td>Mark Handcock</td>
<td>University of Washington</td>
<td>Statistics</td>
<td>22</td>
</tr>
<tr>
<td>David C. Heath</td>
<td>Carnegie Mellon</td>
<td>Mathematical Sciences</td>
<td>50</td>
</tr>
<tr>
<td>Ulrich Horst</td>
<td>Humboldt Universtitat zu Berlin</td>
<td>Mathematics</td>
<td>75</td>
</tr>
<tr>
<td>David R. Hunter</td>
<td>Pennsylvania State University</td>
<td>Statistics</td>
<td>22</td>
</tr>
<tr>
<td>Christina Kendziorski</td>
<td>University of Wisconsin</td>
<td>Biostat. and Med. Informatics</td>
<td>108</td>
</tr>
<tr>
<td>Mohammad Kazim Khan</td>
<td>Kent State University</td>
<td>Mathematics</td>
<td>303</td>
</tr>
<tr>
<td>Dohyun Kim</td>
<td>Seoul National University (SRCCS)</td>
<td>Statistics</td>
<td>171</td>
</tr>
<tr>
<td>Hye-Ryoung Kim</td>
<td>Seoul National University (BK 21 Math-SNU)</td>
<td>Mathematics</td>
<td>134</td>
</tr>
<tr>
<td>Hyejin Ku</td>
<td>York University</td>
<td>Mathematics and Statistics</td>
<td>29</td>
</tr>
<tr>
<td>Thomas G. Kurtz</td>
<td>University of Wisconsin</td>
<td>Mathematical Sciences</td>
<td>267</td>
</tr>
<tr>
<td>Jeong HyunLee</td>
<td>Seoul National University (SRCCS)</td>
<td>Mathematics</td>
<td>95</td>
</tr>
<tr>
<td>Taerin Lee</td>
<td>Seoul National University (SRCCS)</td>
<td>Statistics</td>
<td>31</td>
</tr>
<tr>
<td>Martina Morris</td>
<td>University of Washington</td>
<td>Sociology and Statistics</td>
<td>22</td>
</tr>
<tr>
<td>Michael Newton</td>
<td>University of Wisconsin</td>
<td>Statistics</td>
<td>108</td>
</tr>
<tr>
<td>Amir Niknejad</td>
<td>University of Illinois - Chicago</td>
<td>Mathematics</td>
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Let me say first that my IMA experience last fall was uniformly positive. The IMA environment fosters excellent individual and collaborative research and it was a treat for me to be involved. I was particularly impressed with the administrative structure, the dedication and care taken by the IMA faculty and staff, and the quality of the facilities, especially the computing infrastructure.

In terms of tangible outcomes of my own research, my time at the IMA allowed me to complete the revision of a manuscript on gene expression data analysis, which has just appeared (citation below). But more importantly, at the IMA I had time to make substantial progress on several major calculations that are central to my research program. . . .

For my research efforts there was another very positive aspect of the IMA visit which was enabled by the collaborative nature of the environment and the many interesting visitors. A mathematical statistics problem on permutation analysis has been of great interest to me and I spoke about it at the Complex Systems Seminar on Oct 8/03. The problem intrigued visitors Greg Rempala and Karen Ball and we have been pursuing a solution since then. We have made good progress towards a solution and we continue to communicate about it since I’ve returned to Madison. The IMA’s commingling of mathematical scientists with diverse interests has in this case lead to a fruitful collaboration which otherwise would not have happened.

– Michael Newton, University of Wisconsin at Madison

Minnesota Mathematics Faculty: Six faculty members from the School of Mathematics were granted teaching release time in order to participate in and contribute to the 2003–2004 annual program. Beyond their participation in workshops and interaction with visitors, their contributions included mentoring of graduate students, delivering and organizing seminars. These faculty members were Greg Anderson, Maury Bramson, Naresh Jain, Richard P. McGehee, Arnd Scheel and Ofer Zeitouni.

Complex Systems Postdocs: During the 2002–2003 academic year, the IMA recruited and hired six postdoctoral scholars with background and/or a strong interest in probability, statistics, or other mathematical aspects of complex systems. The postdocs have been involved in all aspects of the thematic program. All are collaborating with other visitors to the IMA. In addition, each has a mentor from the permanent University of Minnesota faculty.

<table>
<thead>
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<th>Mentor</th>
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<td>2003</td>
<td>Douglas Arnold</td>
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<td>Karen Ball</td>
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<td>2003</td>
<td>Ofer Zeitouni</td>
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<td>Maury Bramson</td>
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IMA Complex Systems year postdocs.

Demographic Data: The postdocs were selected from a large and very competitive applicant pool. For the 2003–2004 year in Complex Systems, there were 77 applicants (38 Asian, 4 Black, 2 Hispanic, 19 White, 14 Unknown). Of these, there were 42 who were judged qualified for the position (22 Asian, 1 Black, 1 Hispanic, 15 White, 3 Unknown). Of these, 6 were hired (2 Asian, 1 Black, 3
Women accounted for 17% of the applicants, 31% of the qualified applicants and 33% of the hired applicants.

**Second Year Postdocs:** Five of the six postdoctoral researchers hired in 2002 for the 2002–2003 Annual Program entitled “Optimization”, remained at the IMA for at least a portion of 2003–2004. Many participated in the Complex Systems program. Their activities during the year are reported in Section 3.10.3. The sixth 2002–2003 postdoc, Lisa Evans, is now an Assistant Professor in the Mechanical Engineering Department at the University of Minnesota.

<table>
<thead>
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</table>

**IMA Optimization year postdocs.**

**Industrial Postdocs:** The IMA industrial postdoc program has been a model program for the education and engagement of young mathematicians in industry. IMA industrial postdocs split their time between the IMA and an industrial lab, where they pursue research in collaboration with an industrial mentor and a group. They are partially supported by industry. The four IMA industrial postdocs during 2003–2004 participated in the Complex Systems program as well.

<table>
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<td>Lili Ju</td>
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<td>VA Medical Center</td>
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**IMA industrial postdocs.**

IMA postdoc Tamon Stephen and IMA industrial postdoc Lili Ju discuss with former IMA postdocs Yvonne Ou and Simon Tavener.
Demographic Data on Long-term Residents

The following table summarizes demographic data for long-term visitors to the IMA during the 2003–2004 program. We include all those who visited the IMA for 2.5 months or longer. In the race column, ‘a’ refers to Asian/Pacific islander, ‘b’ refers to Black non-Hispanic, ‘w’ refers to White non-Hispanic, and ‘h’ refers to Hispanic.

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</table>

Resolving complex problems to simple component parts is one of the cornerstones of mathematical thought, but, in the end, many of the phenomena we observe are interrelated and so much is lost in piecemeal analysis. A “complex system” is a system with a very large number of interacting parts such that the interactions are nonlinear in the sense that we cannot predict the behavior of the system simply by understanding the behavior of the component parts.

The 2003–2004 IMA annual program focused on three particular kinds of complex systems: the genome (in the fall quarter), large-scale communication networks (in the winter quarter) and financial markets (in the spring). These systems share the common feature that there is a huge amount of available data describing them. Mathematical models developed for these systems must be informed by this data if they are to provide a basis for scientific understanding of the systems and for critical decision-making about them.

The organizing committee for the annual program consisted of Thomas G. Kurtz (University of Wisconsin, Madison), Marco Avellaneda (Courant Institute, NYU), Bruce Hajek (University of Illinois, Urbana), Richard Karp (UC Berkeley), Sallie Keller-McNulty (Los Alamos National Labs), Andrew Lo (MIT), Michael Newton (University of Wisconsin, Madison), Simon Tavaré (University of Southern California) and Walter Willinger (AT&T Labs-Research)

3.2.1 Workshops in the Annual Program

A great deal of thought is put into the planning and organization of IMA workshops. The aims and goals of individual workshops are determined through discussions between the workshop organizers, program organizers, and IMA directors, and the format of the workshop tuned accordingly. As a general matter, the IMA puts a high priority on discussion and communication across disciplinary and scientific community boundaries. Therefore we are careful to leave ample time for discussion in our programs. Workshops often start with a few presentations that give a broad overview and help to cut through discipline-specific jargon. During the 2002–2003 program, we adopted “Second Chances” discussion periods at the end of the day for many workshops, and this has continued into the 2003–2004 program. During these sessions the day’s speakers have a chance to revisit a point from their lecture in light of the discussions that occurred afterward, and the participants, having had a chance to digest the lectures, had the opportunity to discuss more meaningfully. “Second Chances” is now scheduled at the end of most workshop days and usually with no ending time. Also, over the last two years, there has been an increased emphasis on poster sessions during the reception at the start of each workshop.
The workshop that I co-organized at the IMA in March 2003 on Semidefinite Programming and Robust Optimization was an enormous success. The resources of the IMA allowed us to bring truly first class researchers in an exciting, emerging area from all over the world. This included senior established people as well as emerging junior stars, and was very much cross-disciplinary, including very theoretically oriented researchers, software developers, and applications-oriented people, especially from the robust control area. Since semidefinite programming is such a hot area, there have been many workshops on the subject in recent years, but the IMA one was particularly notable exactly because its resources allowed it to bring many participants without everyone giving a talk - at so many workshops, there are far too many talks and one gets exhausted from information overload. At the IMA conference, the number of talks was very manageable and the quality of the talks was extremely high, as we were very selective about who we invited to give a lecture. People particularly liked the Second Chances sessions. Speaking for myself, I am about to depart for Toulouse, France for a month-long visit; my host is Didier Henrion, with whom I have initiated a research project on polynomial stabilization via nonsmooth optimization. We began this project in the computer lab at the IMA one afternoon during the conference and are excited about continuing it. I had never met him before the IMA workshop and knew little about his work, which is very interesting; this is a great example of a collaboration between areas that would not have occurred without the workshop impetus.

– Michael Overton, Courant Institute

At the IMA workshop, I met John Scales from Colorado School of Mines. We discovered that we are both interested in surface wave scattering and are both complementary: John has been doing very interesting physical modeling experiments whereas our group has been developing modeling and imaging schemes. We joined forces and by now this has resulted in some very interesting results and joined papers. There have also been visits between Colorado School of Mines and Delft University PhD students and staff.

– Gerard Herman, Delft University of Technology, referring to the IMA Workshop “Inverse Problems and Quantification of Uncertainty”, held April 2002

The following workshops were held as part of the 2003–2004 annual program on Complex Systems. Workshops 1 to 3 occurred in the first quarter which concentrated on Genome Sciences. The second quarter concentrated on Communication Networks, highlighted by workshops 4 to 6. The final quarter concentrated on Finance and involves workshops 7 to 9.

Fall Quarter: Mathematical and Statistical Problems in Genome Sciences

Organizers: Michael A. Newton (University of Wisconsin at Madison) and Giovanni Parmigiani (Johns Hopkins University).

An excellent workshop in every aspect: impact, content, format etc. I have had the pleasure of making new friends and have gained tremendously from the lectures and discussions/debates. I did learn lots of new things and came back with some challenging issues that I hope to spend time and contribute towards future methodological advance.

– Joseph Beyene, Hospital For Sick Children, Toronto
2. Comparative Genomics (IMA/RECOMB Workshop), 20–24 October 2003. Organizers: Jens Lagergren (Royal Institute of Technology in Stockholm), Bernard Moret (University of New Mexico) and David Sankoff (University of Ottawa).


**Winter Quarter: Communication Networks**

4. Measurement, Modeling and Analysis of the Internet, 12–16 January 2004. Organizers: Bruce Hajek (University of Illinois at Urbana–Champaign) and Don Towsley (University of Massachusetts).

> I greatly enjoyed the workshop. I found the format nice with only 3 or 4 talks per day with plenty of time to do each talk justice. . . . I learned about subjects I have not yet considered and that was useful and informative and there is at least one subject I hope to look at more closely . . . – Jim Roberts, France Telecom R&D


> Excellent. Learned a lot about biology and control theory. Met interesting people with whom I hope to collaborate in the future. Amazingly, I think I went to every talk, even those during the tutorial, something I doubt I've ever done before at any meeting. 
> – Howard Karloff, AT&T Labs – Research

6. Control and Pricing in Communication and Power Networks, 8–13 March 2004. Organizers: Christopher L. DeMarco (University of Wisconsin at Madison), Thomas G. Kurtz (University of Wisconsin at Madison) and Ruth J. Williams (University of California, San Diego).

> I have worked in the networks area for over ten years, but only began considering power networks recently. There is a tremendous language and academic-cultural barrier surrounding the power systems literature. The tutorial on Sunday, March 7, especially the lecture by Prof. DeMarco helped to clarify the central issues. It was useful to try to bring together researchers in respectively power and communication systems. The issues are more closely connected than I would have thought. For example, currently the power industry has a combination of high-profit and great turmoil, while the communication industry is stagnating. One conclusion from the workshop is that this is simply a matter of over-provisioning of resources in the case of the communications industry. I made many new contacts. Some of us plan to get together at the Allerton conference on communication and control this Fall for a special workshop on power systems. This will be a first at Allerton. – Sean Meyn, University of Illinois at Champaign-Urbana

**Spring Quarter: Information Technology and Optimization**

The workshop was extremely interesting and it opened some new lines of research. The diversity of speakers, in terms of both their specific field of study within financial maths and of their affiliation, contributed to the vivacity of the discussion, both at the ordinary workshop sessions and afterwards. I appreciated very much the idea of papers posted in advance, as they allow for some better understanding of the topics of talks.
– Francesco Rapisarda, Banca IMI


3.2.2 Tutorials and Short Courses

In 2003–2004, by popular demand, the IMA continued to offer a variety of tutorials and short courses. As in the preceding year, we began with a “kickoff” tutorial, which was a one-week long introduction to complex systems. During the year, the we organized several other tutorials and a short course designed to give an introduction to specific topics in complex systems program, and generally aligned with, and immediately preceding, individual workshops.
In 2003–2004, by popular demand, we have continued our increased focus on tutorial/short courses. As in the preceding year, we began with a “kickoff” tutorial, which was a one-week long introduction to complex systems.

Below we list the tutorials and short courses for the Complex Systems year:

1. Tools for Model and Data Integration in the Genome Sciences, 15–19 September 2003. Organizers: Sallie Keller-McNulty (Los Alamos National Laboratory), Michael A. Newton (University of Wisconsin at Madison) and Simon Tavare (University of Southern California).

2. The Internet for Mathematicians, 7–9 January 2004. Organizers: Walter Willinger (AT&T Labs - Research) and Bruce Hajek (University of Illinois at Urbana–Champaign).


5. Control and Pricing in Communication and Power Networks, 7 March 2004 IMA Tutorial. Organizers: Christopher L. DeMarco (University of Wisconsin at Madison), Thomas G. Kurtz (University of Wisconsin at Madison) and Ruth J. Williams (University of California, San Diego).


3.3 Summer Program 2003: Probability and Partial Differential Equations in Modern Applied Mathematics

The summer program took place from July 21 to August 1, 2003, and was organized by Edward C. Waymire (Oregon State University) and Jinqiao Duan (Illinois Institute of Technology). The engagement of graduate students was an important feature of this summer program.

This program was devoted to the role of probabilistic methods in modern applied mathematics from perspectives of both a tool for analysis and in modeling. Researchers involved in contemporary problems involving dispersion and flow, e.g., fluid flow, cash flow, genetic migration, flow of internet data packets, etc., were selected as speakers and to lead discussion groups. There is a growing recognition in the applied mathematics research community that stochastic methods are playing an increasingly prominent role in the formulation and analysis of diverse problems of contemporary interest in the sciences and engineering. In organizing this workshop, an explicit effort was made to bring together researchers with a common interest in the problems, but with diverse mathematical expertise and perspective.
A probabilistic representation of solutions allows one to exploit the power of stochastic calculus and probabilistic limit theory in the analysis of deterministic problems, as well as to offer new perspectives on the phenomena for modeling purposes. In addition such approaches can be effective in sorting out multiple scale structure and in the development of Monte Carlo type numerical methods.

The inclusion of stochastic terms in the modeling of complex flows is receiving widening attention. The addition of such terms has led to interesting new mathematical problems at the interface of probability, numerical analysis, and partial differential equations. During the last decade, significant progress has been made towards building a comprehensive theory of random dynamical systems, statistical cascades, stochastic flows, stochastic pde’s, etc. Some core questions in the modeling, analysis and simulation of complex flows under uncertainty are: exploring appropriate ways to take stochastic effects into account; understanding the impact of randomness on the evolution of complex systems; and designing efficient numerical algorithms to simulate random phenomena.

The workshop was very stimulating with the programme covering a number of interesting inter-related topics. I gained an insight into problems related to my own interests and became aware of areas of interest which look likely to have a direct impact on my research. I will most certainly follow up some papers which have been brought to my attention. – Ian Davies, University of Wales Swansea

3.4 Summer Program 2004: $n$-Categories: Foundations and Applications

The summer program took place 7–18 June 2004. It was organized by J. Peter May (University of Chicago) and John Baez (University of California at Riverside). Higher category theory concerns higher level notions of naturality, which can be expressed as maps between natural transformations, maps between such maps. Just as the original definitions of Eilenberg and MacLane gave a way of thinking about categorical structures and analogies between such structures in different fields, higher category theory promises to allow serious thinking about and study of higher categorical structures that appear in a variety of specific fields. The need for such a language has become apparent, almost simultaneously, in mathematical physics, algebraic geometry, computer science, logic, and, of course, category theory. Such a language and a relevant body of results is already implicit throughout algebraic topology. In all of these areas, higher categorical structures are there in nature, and one needs a coherent way of thinking about them. The program had 70 participants, almost all of whom remained for the entire duration.

3.5 Hot Topics and Special Workshops

One possible pitfall of the long IMA planning cycle is the inability to respond effectively to a rapidly changing world. The IMA plans its annual themes four to five years in advance, and its summer programs about two years in advance. In order to maintain a certain nimbleness when events call for it, the IMA has instituted Hot Topics workshops that need not be related to the annual or summer themes, and can be planned in less than one year.

During 2003–2004, the IMA mounted four hot topics workshops. In all these special workshops, the IMA’s goal is to develop and nurture new interdisciplinary research efforts in which mathematics can
play an essential role. It does this by promoting cross-disciplinary interchange, and by highlighting problems and opportunities for mathematics, and mathematical techniques potentially applicable to the problem area.

3.5.1 Agent Based Modeling and Simulation

Held 3–6 November 2003. Organizers: Filippo Castiglione (IAC “M. Picone CNR, Italy), Jane K. Cullum (Los Alamos National Laboratory), Stephen Eubank (Los Alamos National Laboratory), Jeffrey O. Kephart (Thomas J. Watson Research Center), Madhav V. Marathe (Los Alamos National Laboratory) and Zoltán Toroczkai (Los Alamos National Laboratory). This conference was cosponsored by the Army Research Office, which contributed $12,000, and by SIAM, which contributed $5,000.

Excellent, broad choice of presenters. At this time in this new area, it is important to throw the net widely and this workshop has done this well. The presentations, many of which are oriented toward broader audiences but still retain technical depth, have resulted in better understanding of the new research directions in this area and help outline potential future research directions. – John Lavery, Army Research Office
3.5.2 Enhancing the Search of Mathematics

Held 26–27 April 2004. Organizers: Michael Doob (University of Manitoba), Thomas Fischer (State and University Library Göttingen), Marc Krellenstein (Elsevier), Robert Miner (Design Science, Inc.) and Robby Robson (Eduworks Corporation). This conference was partially funded by the National Science Digital Library program through a grant to Design Science, Inc., which contributed $24,350. The purpose of the workshop was to identify promising ways of better searching mathematical content and to identify a framework for activity leading to the adoption and deployment of improved mathematical searching. As an outcome of the workshop a position paper and agenda for progress were drafted and are now being discussed.

I found the workshop to be of great value. It provided me with a much clearer understanding of the critical path milestones that we must achieve, identified several areas of promising work that is currently in progress, and confirmed several key strategic decisions that my organization has made for the future. – Ted Kull, SIAM

3.5.3 Compatible Spatial Discretizations for Partial Differential Equations

Held 11–15 May 2004. Organizers: Douglas N. Arnold (University of Minnesota), Pavel Bochev (Sandia National Laboratories), Rich Lehoucq (Sandia National Laboratories), Roy Nicolaides (Carnegie-Mellon University) and Mikhail Shashkov (Los Alamos National Laboratory). This conference brought together a spectrum of scientists at the forefront of research in all major branches of numerical solution of PDEs (finite elements, finite difference, finite volumes, spectral methods, ...) to discuss compatible spatial discretizations, defined as those discretizations that inherit or mimic fundamental properties of the PDE such as topology, conservation, symmetries, and positivity structures and maximum principles. It was cosponsored by the U.S. Department of Energy, which contributed $36,420.

The impact was very high. I was particularly impressed with the large number of world-famous researchers from Europe who attended the conference. I met many new contacts in my field. And I got some ideas for solving a particular problem I am working in. – Daniel White, Lawrence Livermore National Laboratories

3.5.4 Adaptive Sensing and Multimode Data Inversion

27-30 June 2004. Organizers: Lawrence Carin (Duke University), George Papanicolaou (Stanford University), Fadil Santosa (University of Minnesota) and Michael Vogelius (Rutgers University). The purpose of this workshop is to gather researchers who work in electromagnetic, acoustic and elastic inverse problems as well as pioneers in the area of adaptive sensing and multimode inversion to address computational, theoretical, and practical challenges of dealing with adaptivity and multimode inversion. It is cosponsored by DARPA and the Army Research Office, who contributed a total of $20,000.
3.6 New Directions Short Course

During 16–27 June 2003, the IMA hosted a two-week intensive short course designed to efficiently provide mathematicians the basic knowledge prerequisite to undertaking interdisciplinary research in the burgeoning field of mathematical biology at the cellular level. The course in Cellular Physiology was taught by James Keener, Professor of Mathematics and Adjunct Professor of Bioengineering at University of Utah and author of the award-winning text Mathematical Physiology and Alexander Mogilner, Professor and Chancellor’s Fellow at the Department of Mathematics and Center for Genetics and Development at University of California at Davis.

The course had two main components. One component dealt with the science of mathematical biology, and covered: the modern state of mathematical biology with emphasis on application in molecular and cell biology and physiology; the mathematical tools ubiquitous in modern mathematical biology; and prominent success and failure cases in mathematical biology.

The second component was designed to provide the participants with the “soft skills” needed in a multidisciplinary research collaboration, and involved presentations on the style mathematical modeling appropriate and necessary in modern computational biology, and problems solving session in which the participants worked in “lab groups” engaged in modeling of typical cell biological phenomena.
Two graduate students, Frank Lynch and Brynja Kohler, from the Department of Mathematics at University of Utah, were recruited to provide assistance in the running of the short course.

The course consisted of two lectures each morning by each of the principal lecturers. An additional topical lecture was given in the afternoon, followed by a problem session. In the problem session, participants work in teams on topics suggested by the topical lecturer. The topical lecturers are shown in the table below.

<table>
<thead>
<tr>
<th>2003 New Directions Topical Lectures</th>
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<tr>
<td>David Odde</td>
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<td>Lihsia Chen</td>
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<td>Robert Sheaff</td>
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<td>Clifton Ragsdale</td>
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<td>Ron Siegel</td>
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<td>Katherine Tosney</td>
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<td>Robert T. Tranquillo</td>
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Towards the end of the first week, the participants organized into five “lab groups”. Each lab was assigned a project on they worked collaboratively. Projects concerned Lac Operon, Vibrio Vulnificus, Calcium Homeostasis, Intercellular Ephaptic Coupling, and Protein Folding. Final reports from each lab were given on the last day of the short course, and materials from the talks are available at the course website.
Participants in the 2003 New Directions Course in Cellular Physiology

*For a newcomer to the Cellular Physiology field like me, this course could not have come at a more opportune time. It provided a most efficient immersion into the field and offered invaluable perspectives that cannot be learned by reading books and articles. Congratulations and thanks to the IMA for conceiving and organizing such an excellent program, and to the instructors, Jim Keener and Alex Mogilner, for carrying it out so successfully. – Vasilios Alexiades, University of Tennessee*

Working together at the IMA.
3.7 Public Lectures

Continuing its emphasis on outreach, the 2003–2004 year included four public lectures, all of which had, as a primary goal, to increase public awareness of the importance and centrality of mathematics in an increasingly technological world.


3.8 Programs for Graduate Students

3.8.1 Mathematical Modeling in Industry

In 2003, the IMA joined forces with the Pacific Institute for the Mathematical Sciences (PIMS) to run the 6th Graduate Industrial Mathematics Modeling Camp (GIMMC) and the 7th Industrial Problem Solving Workshop (IPSW). This has been reported in the 2003 annual report. The 2004 Mathematical Modeling in Industry workshop will take place from August 9 to 18 at the IMA. Plans for this program are given in Section 5.1.5.

3.8.2 Participating Institute Summer Programs for Graduate Students

From July 14 to August 1, 2003, the IMA held a 2-week program “Combinatorics and its Applications” at Georgia Institute of Technology. A total of 58 students participated in the program. The main lectures were given by

- Graham Brightwell, Department of Mathematics, London School of Economics.
- Andras Gyarfas, Applied Mathematics Laboratory, Hungarian Academy of Sciences.
- Prasad Tetali, School of Mathematics, Georgia Institute of Technology.
- Robin Thomas, School of Mathematics, Georgia Institute of Technology.
- William Trotter, School of Mathematics, Georgia Institute of Technology.

Topics covered included discrete structures, extremal problems, discrete optimization, Ramsey theory, probabilistic and linear algebraic methods, enumeration and complexity.

The program was excellently conducted, with brilliant minds sharing views on “Combinatorics and its Applications” for the entire duration of the program. As a participant, I think I took home more than I expected. It was my first experience in a workshop as a graduate student, and a very valuable one at that.
– Tejas Iyer, Georgia Tech

Mathematically, the past three weeks were the best of my life. I learned a number of proof techniques and ideas that I hope to apply in my own research... The program was exceptional in every aspect. All the little details like the weekly receptions and the daily catering served to enhance the mathematical program. I am very grateful to have been selected to participate. I learned quite a bit, met many great people whom I expect to remain in contact with, and had an exceptional three weeks.
– Craig Larson, University of Houston

The graduate summer program proved valuable not only for the students, but for the lecturers as well:
As a result of our attendance at the IMA summer program in combinatorics at Georgia Tech this summer, Prasad Tetali and I have written a joint paper entitled “The Number of Linear Extensions of the Boolean Lattice”. The paper involves using a technique that Prasad described in his talks at the meeting to make substantial progress on a problem that I highlighted in one of my talks. – Graham Brightwell, lecturer in the 2003 summer program for graduate students

During 8-26 June 2004, at the University of Notre Dame, the IMA held a summer program for graduate students on the topic “Coding and Cryptography”. The lecturers for this program will be G. David Forney, Jr. (Massachusetts Institute of Technology), James L. Massey (ETH Zurich), Michael E. O'Sullivan (San Diego State University), Vera Pless (University of Illinois at Chicago), Joachim Rosenthal (University of Notre Dame) and Andreas Stein (University of Illinois at Urbana-Champaign). Not counting the 6 speakers and 20 junior faculty serving as mentors and group project leaders, we expect 58 participants.

3.9 PI Conferences

As part of the Participating Institute program (see Section 4.3), the IMA provides funding and advertisement for conferences proposed by, and held at, Participating Institutes. Moreover, IMA monies from the Participating Institute program can be used for participants to travel from a PI institution to any of these conferences. Proposals for IMA PI conferences are reviewed by representatives from the PIs and are selected for funding by a committee consisting of PI mathematics department chairs. These conferences are on a variety of topics and are valuable in promoting collaboration among Participating Institutions.

1. Great Lakes Geometry Conference, University of Wisconsin, May 1–4, 2003. Organizers: Jeff Cheeger (New York University), X. Chen (University of Wisconsin-Madison), and Herman R. Gluck (University of Pennsylvania)

2. Symposium in Analysis and PDEs, Purdue University, May 23–26, 2003. Organizer: Donatella Danielli (Purdue University)

3. Asymptotic Problems in Stochastic Processes and PDE’s: A conference in honor of the 65th Birthday of Professor Mark I. Freidlin, University of Maryland at College Park, May 29–May 31, 2003. Organizers: Richard Sowers (University of Illinois at Urbana-Champaign), Tzong-Yow Lee (University of Maryland at College Park), and Isaac Sonin (University of North Carolina at Charlotte)


3.10 Postdoctoral Program

Through its postdoctoral program the IMA has helped to train and to broaden many mathematicians during the early stages of their career. Many of our former postdocs are now leaders in their fields. Central to this career development program is the exciting research environment that the IMA provides. The IMA places a priority on careful mentoring of postdocs. Each postdoc is assigned a mentor drawn from the mathematics faculty at the University of Minnesota, or from other departments on campus. The postdocs are encouraged to collaborate with IMA long-term visitors.

The benefit of my academic year at the IMA has been manifold. My interactions with the researchers currently visiting the institute has certainly been very fruitful. At the same time, my participation in the workshops in this year’s program, particularly those related to stochastic problems in biology, has been extremely valuable. The main privilege of working at the IMA for me has been the opportunity to broaden my horizons and devote the time to get involved in new research areas. This will enable me to direct my future research into areas particularly in need of development.

– Lea Popovic, IMA Postdoc, 2003–2004

Each year the IMA forms a hiring committee to evaluate the applications for postdoctoral positions. For the Complex Systems year the committee consisted of Don Aronson, Marco Avellaneda, Tom Kurtz, Wei Pan, Fadil Santosa and Ofer Zeitouni.

The table above shows that the IMA postdoctoral program is becoming increasingly well-known and popular among finishing graduate students.
3.10.1 Complex Systems Postdocs

The IMA appointed six postdocs for the annual program in Complex Systems. Karen Ball will return to Indiana University next year. Antar Bandyopadhyay plans to work at Chalmers University in Gothenburg, Sweden. Chuan-Hsiang Han will become an IMA Industrial Postdoc in a position jointly funded with Ford. The rest will remain at the IMA for 2004–2005 to further pursue research. Some will take on teaching duties to round out their experience.

The IMA has created an incredible atmosphere for young mathematicians to learn, develop, and create new research projects. More importantly, it helps us to build academic and industrial networks because the workshops held at the IMA have been designed carefully by the most leading researchers. – Chuan-Hsiang Han

Gerard Awanou PhD 2003 in Mathematics from the University of Georgia. With Antar Bandyopadhyay, he has organized the Postoc Seminar during the 2003–2004 year. His area is numerical analysis and mathematical finance, with recent interest in the multivariate spline method for PDEs and finite elements. His mentor is Doug Arnold. For experience, he plans to teach an undergraduate course in the University of Minnesota mathematics department next year.

Karen Ball PhD 2002 in Mathematics from the University of Maryland. Her area is dynamical systems and ergodic theory, specifically in analyzing conditions guaranteeing that a system which is stochastically dominated by another must be a factor. She is also participating in a group of visitors and postdocs, including Tom Kurtz, which is exploring multiscale modeling of chemical equations in biological systems. Her mentor is Richard McGehee. She plans to spend the next academic year at Indiana University at Bloomington, working with Russell Lyons.

Antar Bandyopadhyay PhD 2003 in Statistics from the University of California Berkeley. With Gerard Awanou, he has organized the Postoc Seminar during the 2003–2004 year. His area is mathematical probability especially probability on trees and graphs. He is involved in
a variety of collaborative projects, working with his mentor, Ofer Zeitouni, as well as with Maury Bramson (Minnesota), David Aldous (Berkeley) and David Gamarnik (IBM Research). He will continue his research at Chalmers University of Technology in Sweden next year.

**Tim Garoni** PhD 2003 in Physics from the University of Melbourne. With Tamon Stephen, he has organized the Brown Bag Seminar during the 2003–2004 year. He has been working on the asymptotic analysis of absolute moments of characteristic polynomials of large random Hermitian matrices. His mentor is Ofer Zeitouni. For experience, he plans to teach an undergraduate course in the University of Minnesota mathematics department next year.

**Chuan-Hsiang Han** PhD 2003 in Mathematics from North Carolina State University. He works on the pricing and hedging of options in multi-factor stochastic volatility models. His mentor is Nicolai Krylov. Next year he will assume the position of IMA Industrial Postdoc, working with Ford Motor Company.

**Lea Popovic** PhD 2003 in Statistics from the University of California Berkeley. Her area is probability theory especially branching processes. Recently she has begun work arising out of conversations with Tom Kurtz on stochastic population models. She is also participating in a group of visitors and postdocs, including Tom Kurtz, which is exploring multiscale modeling of chemical equations in biological systems. Her mentor is Maury Bramson. For experience, she plans to teach an undergraduate course in the University of Minnesota mathematics department next year.

> I think my decision of coming to IMA as a postdoctoral fellow was a very correct one and will be extremely helpful for my future career. It is not only that while here I got involved with several research projects with some of the faculties from the Mathematics Department of University of Minnesota but also the various workshops, tutorials, short courses and seminars organized by IMA gave me a broader perspective about research in theoretical and applied probability in general. Moreover it also helped me to get more contacts and in some cases opportunity to collaborate with some of the visitors.

– Antar Bandyopadhyay

### 3.10.2 Second Year Postdocs

With the exception of Lisa Evans, now an Assistant Professor in the Mechanical Engineering Department at the University of Minnesota, all of the postdocs hired for the IMA 2003–2004 thematic program in Optimization chose to remain for all or part of a second year at the IMA. The five remaining postdocs are:

**Olga Brezhneva** PhD 2000 from the Computer Center of the Russian Academy of Sciences. Dr. Brezhneva’s research area is nonlinear constrained optimization. Her mentor is Hans Weinberger. She will join the faculty of Miami University in Ohio in Fall 2004.

**Balaji Gopalakrishnan** PhD 2002 in Industrial Engineering, Georgia Institute of Technology. Dr. Gopalakrishnan’s research is centered on approximation algorithms for Combinatorial Optimization Problems. His mentor is Ding-Zhu Du in Computer Science and Engineering. He joined the research staff of SAS in December 2003.
Herve Kerivin  PhD 2000 from the Université Blaise Pascal. Dr. Kerivin’s appointment is joint with the University of Minnesota Digital Technology Center, and his research is on network design problems. His mentor is Andrew Odlyzko. Next year he will assume a faculty position at the University of Clermont-Ferrand 2 in France.

Tamon Stephen  PhD 2002 from the University of Michigan. With Tim Garoni, he has organized the Brown Bag Seminar during the 2003–2004 year. Taught a linear algebra course in the School of Mathematics at the University of Minnesota in Fall 2003. Dr. Stephen’s research is on combinatorial optimization problems. His Mentor is Victor Reiner. He will join McMaster University in Hamilton, Ontario in Fall 2004.

Jing Wang  PhD 2002 from the University of Minnesota. Dr. Wang’s research is on optical lens design and numerical relativity. His mentor is Douglas Arnold. He will be employed at Johnson&Johnson in their Spectacle Lens Group starting October 2004.

The great IMA environment has made the course of a wide research activity possible and easier. Moreover, the IMA postdoctoral position has permitted me to develop a high level of optimization theoretical skills while emphasizing the importance of the industrial enforcement, through the numerous workshops organized at the IMA. – Herve Kerivin

3.10.3 Industrial Postdocs

Four industrial postdocs were in residence at the IMA during the reporting period

Bilgin Altundas  PhD from the University of Pittsburgh. He continued his collaboration with Schlumberger and joined the staff of Schlumberger Doll Research in January 2004.

Lili Ju  PhD from Iowa State University. He continued his collaboration on brain imaging with the VA Medical Center. He will join the faculty of the University of South Carolina.

Haewon Nam  PhD from Texas A&M University. Dr. Nam continued to work on MRI and left the IMA in April 2004 to join a bio-imaging research group led by Professor Rosemary Renault at Arizona State University.

Jun Zhao  PhD from Texas A&M University. Dr. Zhao returned to his research in numerical analysis. He is expecting to begin working at Therma-Wave, Inc., next year.

3.10.4 Articles by IMA Postdocs


Postdoctoral Program – 33


Haewon Nam: joint with Sarah Patch, Feasibility of MRI with Inhomogeneous Background Fields, Proceedings of the VIIth International Conference on Fully 3D Reconstruction in Radiology and Nuclear Medicine, Saint-Malo, France, 20003.


Tamon Stephen: The distribution of values in the quadratic assignment problem, Mathematics of Operations Research 28 (1) 2003, pp. 64–91. On the Distribution of Values in the Quadratic Assignment Problem, joint with A. Barvinok, chapter (pp. 1–16) in: Novel Approaches to


3.10.5 Talks by IMA Postdocs

Gerard Awanou: Trivariate Spline Approximations of 3D Navier-Stokes Equations invited talk at the Joint Math Meetings in Phoenix. Also spoke at IMA.

Karen Ball: Factors of i.i.d. Processes on Groups and Graphs, IMA Postdoc seminar. Same title, Probability Seminar at Indiana University in Bloomington and Probability and Ergodic Theory Seminar at The Ohio State University in Columbus.


Tim Garoni: Absolute Moments of Products of Characteristic Polynomials, and Impenetrable Bosons, I & II, Random Matrix Seminar, Department of Mathematics, University of


**Jing Wang:** Analysis of a Variational Approach to Multi-Focal Lens Design, Department of Mathematics, University of California-San Diego, 2004. Analysis of a Variational Approach

3.11 Seminars

3.11.1 Industrial Problems Seminar

The Industrial Problems Seminar, jointly sponsored by the IMA and the Minnesota Center for Industrial Mathematics (MCIM), continues to be vital after 17 years. The seminar met 16 times during this reporting period, featuring speakers from industry. The seminars are well-attended, with the audience primarily consisting of IMA postdocs and visitors, of MCIM graduate students and of faculty, although some talks drew audience from nearby companies and other departments on campus.

The list of speakers for 2003-4 and the titles of their talks is provided below. Each speaker normally spends a day at the IMA and is given an agenda which includes speaking to postdocs and students. While the aim of the seminar is to provide a forum by which the audience can learn the breadth of the utility of mathematics by finding out how mathematics is used in solving real-world problems in industry, the seminar also provides students and postdocs the opportunity to explore summer and permanent positions at the companies represented by the speakers. Many of the talks are available as streaming video, along with files of the presentations.

1. Robert Crone (Seagate Technology, Minneapolis, MN), Applied mathematics and disk drive design.
2. Dipak Chowdhury (Corning Inc, Corning, NY), Simulation of extreme events in optical communication.
3. Indraneel Das (United Technologies Research Center, Hartford, CT), Challenges in industrial optimization ... technical or otherwise.
4. Dharmashankar Subramanian (Honeywell Labs, Minneapolis, MN), Mathematical programming and multi-aircraft conflict resolution.
7. Scott Shald (Coherent Technologies, Inc. Lewisville, CO), Modeling of a natural gas pipeline leak sensor.
8. Edward Keyes (Orisar / Semiconductor Insights), Open algorithmical problems in the analysis of integrated circuits.
9. Dan Wack (KLA-Tencor), Application of inverse electromagnetic scattering to critical dimension measurement and control in semiconductor production.
10. William H. Frey (General Motors), *Modeling buckled developable surfaces for binder design in sheet metal forming*.


13. Ilya Kolmanovsky (Ford), *Parameter governors for constrained nonlinear systems*.


15. William Morokoff (Moody’s KMV LLC), *Modeling and computational challenges in measuring portfolio credit risk*.

16. Apo Sezginer (Invarium Inc., San Jose, CA), *How to fit 100 million transistors on a thumbnail*.

### 3.11.2 IMA Postdoc Seminar

The seminar is organized by the IMA postdocs and meets weekly except during a workshop week. Speakers are drawn from the postdocs, other visitors and School of Mathematics faculty. An important goal of the seminar is to generate interaction among residents of the IMA with the hope of creating new collaborations. This seminar also provides a forum for the IMA postdocs to communicate their findings with annual program members and to hone their presentation skills. It has been effective channel for generating interaction between these two groups with different interests.

### 3.11.3 Complex Systems Seminar

A seminar on themes related to the annual program theme of optimization was offered during the annual program. Speakers, frequently IMA visitors and postdocs, give informal lectures related to the theme of annual program.

### 3.11.4 Brown Bag Seminar

The IMA brown bag seminar meets weekly for informal presentations of mathematical topics or open problems. The speakers include many IMA post-docs and visitors, so the topics usually match the IMA’s annual theme. The audience members bring lunch and are encouraged to engage the speaker in discussion.

### 3.12 Industrial Program

The IMA’s industrial program, started in 1987, has become a major activity with many accomplishments. It continues to grow with tangible benefits to the mathematical sciences community and to the companies involved.
3.12.1 Industrial Problems Seminar

Started in 1987, the IMA Industrial Problems Seminar is a forum in which industrial researchers give presentations on their work. The presentation typically highlights how mathematics play a role in the work, and serves to give the IMA participants a view into industrial research. The seminar speaker typically spends an entire day at the IMA, meeting with postdocs and students. They often lead to further collaborations. Companies have use the forum to recruit permanent employees and summer interns. The IMA uses this opportunity to develop further partnerships.

A listing of the seminars is given in Section 3.11.1.

3.12.2 Industrial Postdoc Program

The concept of Industrial Postdoc was invented at the IMA in 1989, with the first postdoc hired in 1990. Under such an appointment, the postdoc spends 50% time working on industrial research with a company under the mentorship of an industrial scientist, and the other 50% time working on their own research. One mechanism for funding under NSF’s GOALI program is modeled after the IMA Industrial Postdoctorate program. Since 1990, 40 industrial postdocs have been appointed, with five presently at the IMA. About half of IMA Industrial Postdocs have gone on to careers in industry, and the remainder have chosen careers in academia. Former industrial postdocs who are at universities include David Dobson, Gang Bao, Nathan Kutz, Nilima Nigam, and Jay Gopalakrishnan.

A list of names of industrial postdocs currently at the IMA and descriptions of their projects is provided in Section 3.10.3.

3.12.3 Industrial Outreach

The IMA Participating Corporation program currently has 15 members: ExxonMobil Corporation, Ford, General Electric, General Motors, Honeywell, IBM, Johnson & Johnson, Lockheed Martin, Lucent, Motorola, Schlumberger, Siemens, Telcordia Technologies and 3M. Each member company is represented in the Industrial Advisory Board, which provides programmatic input to the IMA. In addition, membership facilitates access to the greater mathematical sciences community with which IMA serves. The Director and Deputy Director maintain open communication channels with each PC, and visit company sites at regular intervals.

3.12.4 Hot Topics Workshops

The hot topics workshop “Enhancing the Search of Mathematics”, 26–27 April 2004, was initiated by Robert Miner of Design Science, Inc., which provided financial support and significant organizational leadership. This workshop also had participation from several publishing companies.

For general information about IMA’s “Hot Topics” workshops, see Section 3.5.
3.12.5 Industrial Math Modeling

The IMA has been running workshops for graduate students in mathematical modeling since 1994. In 1998, the IMA decided to redesign the program in order to focus on industrial research. The idea is to give the graduate student participants an experience in solving real world problems arising in industry. The format of the workshop involves creating 6 teams consisting of 6 students, each working under the supervision of an industry mentor, who pose the problem on the first day of the workshop. By the 10th day, the students must provide an oral and written report on their work.

The program has been popular not only with the students but also with the companies. Indeed, the in-kind contribution provided by the company is immense considering that the mentor spends 10 days at the IMA. The program runs every two years and is oversubscribed. In 2004, the IMA received over 45 applications for the 33 places it offers. Details of the program are provided in Section 5.1.5.

3.13 Impact Assessment

The primary mission of the IMA is to foster interdisciplinary research linking mathematics and to strengthen the talent base of researchers able to carry out such research. Thus, the most important outcomes of the IMA’s activities include new collaborations and new interdisciplinary research projects and results. While such outcomes grow from seeds planted at the IMA during IMA programs, they usually begin to grow and bear fruit at a distance, in both time and space, from the IMA. It is therefore challenging to assess our success in achieving such outcomes. The synopses that follow, collected from follow-up discussions and reports of IMA participants, provide examples of the kind of interactions and research that derive from IMA programs. There are many such examples (more of which can be found in the participants’ reports in the attachments to this annual report), and undoubtedly many others of which we are not aware. Although difficult to quantify, it seems clear that the IMA is among the most successful institutions in the world in stimulating interdisciplinary mathematical collaborations and research.

From mentor to partner. Xiao-Song Lin was an instructor in the IMA graduate student summer program on Topology of Manifolds in 1998 and Ilya Kofman was a student there. Kofman’s thesis was a direct outcome of their interaction, and Lin and Kofman are now collaborators with a publication in Topology (2003). Kofman writes that he “remembers that summer as the most mathematically enriching summer of my graduate education...The program was structured to provide many hours of time for conversation with the instructors, and I took full advantage of it. I recall the thrill of seeing new insights on active research topics, and it had an energizing effect on my graduate education.”
Hexapods crawl out of IMA program. The IMA workshop on animal locomotion in June 1998 launched a collaboration between Bob Full, John Guckenheimer, Phil Holmes, and Dan Koditschek. Their project, which includes the development of spectacular autonomous hexapod robots like the one pictured at right, has been funded for several years by DARPA and recently led to a proposal to the Frontiers in Integrative Biology program at the National Science Foundation. In a forthcoming invited SIAM Review paper, Holmes, Full, Koditschek, and Guckenheimer describe the initiation of the project: This paper, and some of our recent work on which it draws, has its origins in a remarkable IMA workshop on gait patterns and symmetry held in June 1998, that brought together biologists, engineers and mathematicians... Workshop discussions in which we all took part also inspired the creation of RHex, a six-legged robot whose unprecedented mobility suggests that engineers can aspire to achieving the capabilities of such fabulous runners as the humble cockroach. In turn, since we know (more or less) their ingredients, such robots can help us better understand the animals that inspired them.

It is rocket science! John Buckmaster and Thomas Jackson, researchers at the University of Illinois’s Center for the Simulation of Advanced Rockets, had been struggling to come up with a method to model heterogeneous solid propellants in rockets. While attending an IMA workshop on combustion, they came across a chapter on sphere packing in an IMA volume on display in the coffee room. The sphere packing algorithm described in the chapter inspired them to devise a new modeling strategy. They have since developed a powerful simulation tool in which the sphere packing strategy they learned at the IMA is the starting point for modeling the solid propellants in rockets. The tool can be used to simulate rockets such as those used in the space shuttle. “We credit the IMA for helping make this breakthrough possible,” says Buckmaster.

Passive tracking. In 1998 engineers at Lockheed Martin Tactical Defense Systems conceived of a new way of tracking potentially hostile aircrafts. Their idea was to use ambient radio frequency signals, such as those from TV and radio broadcasts, to illuminate the targets, leaving the targeted aircraft unaware it was being watched. Lockheed Martin turned to the IMA and engaged Industrial Postdoc Aleksandar Zatezalo, a fresh PhD trained in probability theory, to move their conception to reality. The collaboration led to a prototype system which successfully tracked commercial aircrafts approaching the Minneapolis-St. Paul International airport, and then to a new business for Lockheed Martin. Chief Engineer Craig Poling says: “Zatezalo’s algorithms are at the foundation of our passive tracking technology, which has become a $4M business for Lockheed Martin. I believe that it keeps us all a little safer as well.” Aleksandar, who is now Research Engineer at defense R&D company Scientific Systems Company, Inc., is justifiably proud of his contributions, but also grateful for the personal benefits he drew from it: “My period as an IMA postdoc at Lockheed showed me what I could do with my mathematics, and helped me find my career.”

Geometry in control. Leading mathematicians from distinct areas were brought together at the IMA’s 2001 summer program on Geometric Methods in Inverse Problems and PDE Control.
Their interactions revealed close connections between classical boundary rigidity problems in geometry and travel-time inversion problems, a well-studied class of inverse problems. This realization together with the new collaborations initiated at the program have already produced significant results and powerful new techniques in both areas. Participant Matti Lassas declared the workshop “one of the best and most interesting I have ever attended,” noting that his recent Inventiones Mathematicae paper coauthored with several of the other workshop participants, would not have been possible without the IMA program.

**The IMA on display.** The programs on liquid crystals sponsored by the IMA since 1984 completely changed the path of liquid crystal research. The effort was led by highly interdisciplinary efforts of mathematicians, with scientists gathering at the IMA from many institutions (for example, Berry, Brezis, Calderer, Cladis, Doi, Ericksen, Hardt, Kinderlehrer, Leslie, Lin, Luskin, Patel, and Palffy-Muhoray). Through the research efforts of these and others, a paradigm shift in the understanding of liquid crystal statics developed based on their modeling as nonconvex problems in the calculus of variations. This led to major progress in long-standing problems, some dating from the 19th century, for example in explaining the structure and stability of defects. Mathematically this research has been very exciting, as evidenced, for example, by the central role it plays in Brezis’s millennium article on “The interplay between analysis and topology in some nonlinear PDE problems,” which appears in the March 2003 Bulletin of the AMS. But this new understanding has proved essential to applications as well, enabling two new video display technologies: polymer dispersed liquid crystal systems and anchoring-breaking mechanisms.

**Decoding the heart’s messages.** Endocardial Solutions, Inc. is a medical-device company marketing a diagnostic system for cardiac arrhythmias, which has so far helped treat over 12,000 patients in 500 hospitals worldwide. At its core is a difficult inverse problem: a balloon catheter with a wire mesh of electrodes is inserted into the heart through a leg vein, and the system must determine what kind of electrical conduction patterns in the heart muscle generated the voltages measured on the balloon’s electrodes. ESI’s mathematicians have had many fruitful discussions with researchers at the IMA, and collaborated with industrial postdoc Tony Varghese to implement an advanced spline geometry model to represent the heart surface in their software. This work has been incorporated into ESI’s main product for computing and visualizing the heart’s electric field for diagnosis.

### 3.14 Demographic Data for Workshops and Tutorials

We list below the gender and race breakdown of the attendees at the IMA workshops, tutorials, hot topics and special workshops, and the mathematical modeling workshop.
### Brief program title

<table>
<thead>
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<tr>
<td>Probability &amp; PDE</td>
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<td>Tutorial: Analysis of internet</td>
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*WNH=White, non-Hispanic; BNH=Black, non-Hispanic; API=Asian/Pacific Islander; HSP=Hispanic.

### 3.15 Publications

The major publications of the IMA are:

- **IMA Newsletters.** A monthly publication listing news and activities for the current month such as workshop schedules, abstracts of talks, public lectures, tutorials, symposium, colloquium, short courses, various seminars including the joint IMA/MCIM seminar on industrial problems, postdocs weekly seminar, brown bag seminar, theme seminars directed by senior researchers, and those run by related departments and centers. Also included are the names of the regular and industrial postdocs, long term visitors and other visitors in residence. For the current and back issues of the newsletters, see www.ima.umn.edu/newsltrs/index.html. An online sign-up list is available to those who would like to subscribe/unsubscribe to the mailing list. See www.ima.umn.edu/lists/.

- **IMA Update Series.** A quarterly web-based publication. It opens with a message from the IMA Director and proceeds with various announcements including the new directions that the IMA is undertaking along with other topics of interests. Each issue includes a recap of what happened within the last few months followed by a description of the current and upcoming programs, and a list of publications. See www.ima.umn.edu/newsltrs/updates/.

- **IMA Preprint Series.** Papers submitted to the series are based on the projects that the IMA visitors have written including their experiences, research initiatives and accomplishments which are derived from their work while in residence. Submitted papers also show results.
Institute for Mathematics and its Applications

of the IMA visitors collaborative work with other mathematicians and other scientists that originated after visiting the IMA, as well as the effect the IMA has on mathematical research community. See www.ima.umn.edu/preprints/complete-list.html for a complete list of technical reports.

- IMA Volume Series. The IMA produces proceedings volumes whose goal is to communicate the results of the various IMA programs ranging from brief but intense workshops, periods of concentration in areas of exceptional interest to extensive thematic workshops and summer programs. Many volumes consist of a collection of high quality refereed papers, with well-written chapters devoted to significant new problems and new approaches to old problems, or reviews or surveys of a significant area of current research. Papers on work-in-progress in of sufficient novelty and interest to warrant publication of preliminary results are also accepted. However, IMA has a policy that articles should not have been submitted or published elsewhere. To date, there are a total of 137 volumes either published or in press. Many IMA volumes have proved to be valuable additions to the literature of the field.

For a complete list, descriptions, and contents of IMA Volumes published by Springer-Verlag New York, Inc., see www.ima.umn.edu/springer/full-list-volumes.html. Springer-Verlag Online Catalogue is also linked to the site.

In addition to the above publications, IMA also distributes frequent updates to the schedules during the workshops in the form of handouts. The goal is to reach those who do not have internet access and to supplement the information posted on the Web. Furthermore, posters of the current and upcoming programs are displayed in various places. Brochures and leaflets containing the IMA Mission and description of programs and other planned activities are also available in several places for perusal.

3.15.1 IMA Preprints

The following list of publications represents a fraction of the research output of the IMA. With the advent of Web-based dissemination of papers, the need for and interest in preprint series like the IMA’s has decreased. Nevertheless, many IMA visitors and members still submit their papers for posting on the IMA Web page due to its wide reach. Below are the preprints in the series from 2003–2004, each preceded by its IMA preprint number.

1923 Lalit Mohan Upadhyaya and H. S. Dhami, Exton’s quadruple hypergeometric functions of matrix arguments-I

1924 Pierre Maurel and Guillermo Sapiro, Dynamic shapes average

1925 Facundo Mémoli and Guillermo Sapiro, Distance functions and geodesics on point clouds

1926 Tuncay Aktosun, Construction of the half-line potential from the Jost function

1927 Tuncay Aktosun, Inverse scattering transform, KdV, and solitons

1928 Collette Coullard, The structure of optimal solutions to the submodular function minimization problem

1929 E. G. Kalnins, J. M. Kress, W. Miller, Jr., and P. Winternitz, Superintegrable systems in Darboux spaces

1930 Vithanage Pemajayantha, On Parameters Repeated Estimation Methods (PREM’s Method) and its applications in data mining

1931 M. M. Ali, Optimization of a telecommunication network with financial considerations

44 – IMA Activities for 2003–2004
1932 Tuncay Aktosun and Vassilis G. Papanicolaou, Recovery of a potential from the ratio of reflection and transmission coefficients
1933 Lalit Mohan Upadhyaya and H. S. Dhami, Lauricella-Saran triple hypergeometric functions of matrix arguments-II
1934 Olga A. Brezhneva and J. E. Dennis Jr., Pattern search methods for linearly constrained minimization in the presence of degeneracy
1935 Debra Lewis, Nilima Nigam, and Peter J. Olver, Connections for general group actions
1936 Christof Melcher, Domain wall motion in ferromagnetic layers
1937 Douglas N. Arnold, Franco Brezzi, and L. Donatella Marini, A family of discontinuous Galerkin finite elements for the Reissner-Mindlin plate
1938 Douglas N. Arnold, Daniele Boffi, and Richard S. Falk, Quadrilateral H(div) finite elements
1939 Alexander M. Alekseenko and Douglas N. Arnold, New first-order formulation for the Einstein equations
1940 Douglas N. Arnold and Alexandre L. Madureira, Asymptotic estimates of hierarchical modeling
1941 Raj Kishore Bisht and H. S. Dhami, Procreation of distribution for words
1942 B. S. Rana and H. S. Dhami, Numerical evaluation of H-function by continued fractions
1943 Lalit Mohan Upadhyaya, Matrix generalizations of multiple hypergeometric functions by using Mathai’s matrix transform techniques
1944 Shmuel Friedland and Uri N. Peled, Theory of computation of multidimensional entropy with an application to the monomer-dimer problem
1945 Christof Melcher, Existence of partially regular solutions for Landau-Lifshitz equations in $\mathbb{R}^3$
1946 Martin Kruzik, Periodic solutions to a hysteresis model in micromagnetics
1947 Tuncay Aktosun, Inverse scattering on the line with incomplete scattering data
1948 Shmuel Friedland, Amir Niknejad, and Laura Chihara, A simultaneous reconstruction of missing data in DNA microarrays
1949 Jianhong Shen and Yoon-Mo Jung, On the foundations of vision modeling IV. Weberized Mumford-Shah model with Bose-Einstein photon noise: Light adapted segmentation inspired by vision psychology, retinal physiology, and quantum statistics
1951 Grzegorz A. Rempala and Jacek Wesolowski, Approximation theorems for random permanents and associated stochastic processes
1952 Shmuel Friedland, Singular value decomposition in DNA microarrays
1953 Guozhen Lu and Biao Ou, A Poincaré inequality on $\mathbb{R}^n$ and its application to potential fluid flows in space
1954 Ana-Maria Matache, Christoph Schwab, and Thomas P. Wihler, Fast numerical solution of parabolic integro-differential equations with applications in finance
1955 Tuncay Aktosun, Vassilis G. Papanicolaou, and Vassilis Zisis, Inverse scattering on the line for a generalized nonlinear Schrödinger equation
1956 B. S. Rana and H. S. Dhami, Numerical evaluation of G-function
1957 Liron Yatziv, Guillermo Sapiro, and Marc Levoy, Lightfield completion
1958 Kedar A. Patwardhan and Guillermo Sapiro, Automatic image decomposition
1959 Leonid Berlyand, Yuliya Gorb, and Alexei Novikov, Discrete network approximation for highly-packed composites with irregular geometry in three dimensions

1960 Tuncay Aktosun and Ricardo Weder, Inverse spectral-scattering problem with two sets of discrete spectra for the radial Schrödinger equation

1961 J. Colliander, M. Keel, G. Staffilani, H. Takaoka, and T. Tao, Global well-posedness and scattering for the energy-critical nonlinear Schrödinger equation in $\mathbb{R}^3$

1962 B. S. Rana and H. S. Dhami, Evaluation of G-function by multiplication and division techniques of continued fractions

1963 Grzegorz A. Rempala and Stephen W. Looney, Asymptotic properties of a two sample randomized test for partially dependent data

1964 Guillermo Sapiro, Eli Hershkovitz, Allen Tannenbaum, and Loren Dean Williams, Statistical analysis of RNA backbone

1965 Alvaro Martín, Guillermo Sapiro, and Gadiel Seroussi, Is image steganography natural?

1966 Scott W. Hansen, Several related models for multilayer sandwich plates

1967 H. S. Dhami, A. K. Singh, G. S. Negi, and Amubha Shah, The general state vector linear model for sustainable ecodevelopment applied on illustrative basis to a sample valley village of Almora district

1968 Khurelbaatar Gonchigdanzan and Grzegorz A. Rempala, A note on the almost sure central limit theorem for the product of partial sums

1969 Katsuki Fujisawa, Mituhiro Fukuda, and Kazuhide Nakata, Preprocessing sparse semidefinite programs via matrix completion

1970 Jianhong Shen, On the foundations of vision modeling V. Noncommutative monoids of occlusive preimages

1971 A. S. Uniyal and Amarendra Behera, Expansion of power of multiple product of trigonometrical functions in terms of sum of multiple angles

1972 A. S. Uniyal and Amarendra Behera, Reduction formula for complicated functions in terms of known results

1973 Shmuel Friedland, Convergence of products of matrices in projective spaces

1974 Yuhong Yang, Prediction/estimation with simple linear models: Is it really that simple?

1975 Peter J. Olver, On multivariate interpolation

1976 H. S. Dhami, A. K. Singh, G. S. Negi, and Bhupendra Singh, Estimation of bias and relative error from the aggregation model developed for a sample valley village of Almora district

3.15.2 IMA Volumes

The IMA has long published a series of volumes, generally connected to its workshops. It is our belief that developments in electronic dissemination have greatly decreased the need for volumes published primarily for their archival value. Therefore, we have agreed with our publisher, Springer-Verlag, to limit the publication of future volumes to cases where materials of particular value, such as tutorial volumes, or state-of-the-art survey volumes, can be produced and similar high quality material does not exist. Our more recent volumes are indeed of this nature, and their value has been confirmed by improved sales. In the future there will be fewer volumes per year, but they will be higher quality and of more lasting value.


Volume 137: Geometric Methods in Inverse Problems and PDE Control. Editors: Christopher B. Croke, Irena Lasiecka, Gunther Uhlmann, and Michael S. Vogelius


4 Governance

4.1 Board of Governors

The IMA Board of Governors oversees the IMA, provides a major source of input for its programs, and approves all major activities and guides the IMA on its major activities. It is an important source of input and advice to the IMA. The members in the 12-member board serve for 3 years. The board meets once per year at the IMA, this year on October 11–12, 2003. New members to the board are elected by the current board. This year the board elected Eitan Tadmor (University of Maryland), Philippe Tondeur (University of Illinois), Ruth Williams (UCSD) and Mihalis Yannakakis (Columbia).

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
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<tbody>
<tr>
<td>Dimitris Bertsimas</td>
<td>MIT</td>
</tr>
<tr>
<td>L. Pamela Cook</td>
<td>University of Delaware</td>
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<tr>
<td>Katherine B. Eno</td>
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<td>Richard James</td>
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<tr>
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IMA Board of Governors

BOG Members with Terms Running Through 2004

Dimitris Bertsimas. Dimitris Bertsimas is the Boeing Professor of Operations Research in the Sloan School of Management at Massachusetts Institute of Technology. His research is principally in stochastic systems, optimization, and finance. He is a member of the Board on Mathematical Sciences and their Applications of the National Research Council.

Richard D. James. Richard James is Russell J. Penrose Professor of Aerospace Engineering and Mechanics at the University of Minnesota. His research centers around materials science and multiscale mathematical models.

James A. Sethian. James Sethian is Professor of Mathematics at the University of California, Berkeley and Department Head of the Mathematics Department at the Lawrence Berkeley National Laboratory. His research interests are in scientific computation and applications.

De Witt L. Sumners. De Witt Sumners is Robert O. Lawton Distinguished Professor of Mathematics and member of the Institute of Molecular Biophysics at Florida State University, where he also serves as chair of the Mathematics Department. His research concerns applications of topology to molecular biology and polymer configuration, and mathematical analysis of human brain functional data.
BOG Members with Terms Running Through 2005

Eitan Tadmor. Eitan Tadmor is Professor of Mathematics and Director of the Center for Scientific Computation And Mathematical Modeling at the University of Maryland and a founding co-director of the NSF Institute for Pure and Applied Mathematics (IPAM). His research concerns the analysis and computation of time-dependent problems in partial differential equations.

Philippe Tondeur. Philippe Tondeur is Emeritus Professor of Mathematics at the University of Illinois. With research interests in differential geometry, he served as Director of the Division of Mathematical Sciences at the National Science Foundation from 1999-2002 and is currently a member of the U.S. National Committee on Mathematics of the National Research Council.

Ruth Williams. Ruth Williams is a Professor in the Mathematics Department at the University of California, San Diego. Her research interests are in probability theory, stochastic processes and their applications.

Mihalis Yannakakis. Mihalis Yannakakis is the Percy K. and Vida L. W. Hudson Professor of Computer Science at Columbia University. His research interests include algorithms, complexity theory, combinatorial optimization, databases, testing and verification.

BOG Members with Terms Running Through 2006

L. Pamela Cook. Pamela Cook is Professor of Mathematical Sciences at the University of Delaware. She is currently also Associate Dean of Engineering. She has served as Chair of her department and as Associate Dean of Arts and Science. Her research interest is in fluid flows, in particular modeling and flows of non-Newtonian fluids. She is currently editor-in-chief of the SIAM Journal on Applied Mathematics.

Katherine B. Ensor. Katherine Ensor is Professor and Chair of Statistics at Rice University. She works on the theoretical development of statistical methods for practical problems. Her primary emphasis is the analysis of dependent data as it relates to environmental statistics and financial statistics.

Robert V. Kohn. Robert Kohn is Professor of Mathematics at New York University’s Courant Institute of Mathematical Sciences. His research focuses mainly on mathematical problems from materials science. He also has a strong interest in quantitative finance, and is among the leaders of Courant’s Mathematics in Finance Masters Program.

T. Craig Poling. Craig Poling is Chief Engineer, Lockheed Martin Tactical Defense Systems.

4.2 Industrial Advisory Board

The Industrial Advisory Board is the industrial counterpart of the IMA Participating Institutions Council. It consists of one representative from each of the IMA Participating Corporations and the non-academic Participating Institutions. The Industrial Advisory Board is an important source of input and oversight for the IMA, and an important conduit for information from the IMA to reach the industrial community. Its members keep aware of IMA activities through emailings, and the Board meets for a full day each year. A typical agenda for the annual meeting includes

- Overview of the IMA and its operations.
- Report on recent, current, and upcoming annual programs.
• Solicitation of potential participants.
• Discussion of future program ideas.
• Scientific lecture related to the upcoming annual program
• Discussion of IMA industrial postdoc program and summer math modeling workshop.
• Discussion of issues relevant to the IMA and industry.
• Open discussion.

On June 8 and 9, 2003, for the first time, the meetings of the Participating Institutions Council and the Industrial Advisory Board were held on consecutive days with a joint session and dinner at the end of the first day. We will have another joint meeting 24 July 2004.

This year Johnson and Johnson and GE Medical joined the Industrial Advisory Board.

Representatives appointed by the the IMA Participating Corporations constitute the IMA Industrial advisory board. This board is also an important source of input and advice to the IMA. The board meets annually.

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<td>Sandia National Laboratories</td>
<td>Mathematics</td>
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*IMA Industrial Advisory Board*

4.3 Participating Institutions Council

The Participating Institutions Council consists of one representative, often the head of the mathematics department, from each academic IMA Participating Institution. The PI Council is an important source of input and oversight for the IMA, and an important conduit for information from the IMA to reach the academic community. The Council is kept aware of the activities of the IMA through regular mailings. It meets for a full day each year. A typical agenda for the annual meeting includes
• Overview of the IMA and its operations.
• Report on recent, current, and upcoming annual programs.
• Solicitation of potential participants.
• Discussion of future directions and ideas for the IMA.
• Selection of PI conferences.
• Discussion of PI summer graduate student program.
• Discussion of future program ideas.
• Suggestions for new members of the Board of Governors.
• Discussions of issues relevant to the Participating Institutions.

There are many benefits to affiliation with the IMA as a Participating Institution:

• Maximal opportunities/minimal barriers for participation. Lots of notification. Prepaid account for travel to or from IMA or other PIs. Preferential treatment for visiting and sabbatical appointments. (More than 40% of participants at the IMA come from affiliates.)
• Direct influence on IMA directions and programming. Annual meeting. Early access to planning documents.
• Access to the IMA scientific community
• PI conference support
• PI summer programs for grad students
• Advocacy, publicity

Each academic IMA Participating Institution appoints a representative to the IMA, most commonly the chair of the Mathematics department. The resulting body is the IMA Participating Institution Council which meets once a year and is consulted on all major activities of the IMA.

This year Rice joined the IMA Participating Institution Council.

Joint meeting of the Participating Institutions Council and Industrial Advisory Board
<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
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<tbody>
<tr>
<td>William T. Trotter</td>
<td>Georgia Institute of Technology</td>
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<td>David Hoff</td>
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<td>Justin Peters</td>
<td>Iowa State University</td>
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<td>Andrew Tonge</td>
<td>Kent State University</td>
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<td>Peter Bates</td>
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<td>Michael M. Neumann</td>
<td>Mississippi State University</td>
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<td>William Blair (Bill)</td>
<td>Northern Illinois University</td>
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<td>Peter March</td>
<td>Ohio State University</td>
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<td>Nigel Higson</td>
<td>Pennsylvania State University</td>
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<td>Leonard Lipshitz</td>
<td>Purdue University</td>
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<td>William W. Symes</td>
<td>Rice University (CAAM)</td>
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<tr>
<td>Katherine B. Ensor</td>
<td>Rice University (Statistics)</td>
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<td>Albert Boggess</td>
<td>Texas A&amp;M University</td>
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<td>Kevin Corlette</td>
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<td>Timothy Hodges (Tim)</td>
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<td>Philip Broadbridge</td>
<td>University of Delaware</td>
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<tr>
<td>Jeff Morgan</td>
<td>University of Houston-University Park</td>
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<td>Joseph Rosenblatt (Joe)</td>
<td>University of Illinois at Urbana-Champaign</td>
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<td>David Manderscheid</td>
<td>University of Iowa</td>
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<td>Peter Perry</td>
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<td>Patrick M. Fitzpatrick</td>
<td>University of Maryland at College Park</td>
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<td>Trevor Wooley</td>
<td>University of Michigan</td>
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<td>Larry Gray</td>
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<td>Steven Buechler</td>
<td>University of Notre Dame</td>
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<td>John Chadam</td>
<td>University of Pittsburgh</td>
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<tr>
<td>David Griffeath</td>
<td>University of Wisconsin at Madison</td>
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<tr>
<td>Sivaguru S. Sritharan</td>
<td>University of Wyoming</td>
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<tr>
<td>Lowell Hansen</td>
<td>Wayne State University</td>
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**IMA Participating Institutions Council**

IMA Participating Institutions (light blue) and Participating Corporations (dark blue)
4.4 Administration and Staff

The directorate of the IMA consists of

- **Douglas N. Arnold, Director.** Arnold was appointed Professor of Mathematics at the University of Minnesota at the same time as he assumed the directorship of the IMA, August 2001. He came to the IMA from Penn State, where he was Distinguished Professor of Mathematics. His research interests include numerical analysis, partial differential equations, mechanics, and in particular, the interplay between these fields. He was a plenary lecturer at the International Congress of Mathematicians in 2002.

- **Fadil Santosa, Deputy Director.** Santosa is Professor of Mathematics at the University of Minnesota. His research interests include inverse problems, optics, and optimal design. He has brought his extensive expertise in industrial applications of mathematics to the management of the IMA since 1997, and also to his work as Director of the Minnesota Center for Industrial Mathematics. Santosa will complete a long period of service to the IMA in August 2004. Arnd Scheel of the University of Minnesota will then assume the position of Deputy Director.

- **Scot Adams, Associate Director.** Adams is Professor of Mathematics at the University of Minnesota. His research interests span a wide variety of topics including geometry and dynamical systems. He joined the IMA directorate in September 2002 and will finish his term in July 2004. Debra Lewis of the University of California at Santa Cruz will take over in this position.

- **Don Aronson, Associate Director for the Postdoctoral Program.** Aronson is Emeritus Professor of Mathematics with a distinguished research career in dynamical systems and partial differential equations. He assumed responsibility for the IMA postdoctoral program...
The IMA staff consists of 10 full time professionals often assisted by one or two part-time student employees. The Senior Administrative Director, Kathy Boyer, oversees the office, trains and supervises staff, and collaborates with staff on specific tasks as dictated by workload. Ines Foss is the IMA Accountant, responsible for all financial transactions and record-keeping, including overseeing of the IMA budget and all grants and contracts. Four administrative specialists, Georgia Kroll, Mavis Swanson, Judy Sweeney, and Orbe Stricherz, form the IMA visitor support staff. They handle invitations, housing, correspondence, database entry, visas, and many other needs of IMA organizers and visitors. In addition they provide general secretarial support. Kumsup Lee and Peter Lawrence form the IMA computing systems group together with an additional part-time student systems administrator. This group is responsible not only for the IMA hardware and software infrastructure, but also for support of the large and ever-changing IMA user community. Patricia Brick is the IMA webmaster, responsible for the creation and maintenance of the extensive and rapidly growing IMA web space. Dzung Nguyen is responsible for the production and distribution of the IMA Volumes book series and the IMA preprint series.

The logistic support and office space are absolutely topnotch, and the IMA staff is extremely helpful, professional and friendly. The perfect ease with which the practical issues were arranged allowed concentration to the content of the program. I can’t think of a single thing to improve. Just keep up the great work! It was really pleasant to visit the IMA. I will be honored if there arises another occasion to come back in the future.

– Elena Dugundji, University of Amsterdam

The logistical support was very good and made participation much more pleasant than other experiences I have had. … The IMA staffs are always helpful, many thanks to them. … IMA staffs are always very helpful and its facilities are great. … The arrangements were superb. … I think the logistics were great. … The logistic support was excellent. … Great, as always. … The logistic support was excellent. The hotel, transportation, and office allocation went seamlessly. Also, speaking as a workshop organizer, the preworkshop juggling due to a last minute cancellation and a rearrangement of schedules went very smoothly. … IMA staff is always helpful and IMA provides quite well logistic support. … Once again all the facilities were great. … As always, the IMA was a very pleasant place to visit. The staff (Judy in particular) are helpful and nice. I love getting an office, a computer, and a hotel room all within about one block of each other. You’re organized extremely well. … The IMA staff are great. I was very pleased with everything. … Excellent, No suggestions … From any viewpoint the logistic support was outstanding. It made it easy to focus on working. … Everything was great. Even wireless in the hotel lobby … couldn’t ask for more! … The overall organization of the workshop was great. … it was perfect … The office supply and logistic support were great. The IMA staff was friendly and competent. … Support and facilities were excellent. Workshop organization was exemplary… –
5 Planning and Outreach

5.1 Program Planning

A major activity for the IMA directors is program planning. The directors work with a wide variety of volunteer organizers and board members from the mathematical sciences and other communities to determine the best topics programs, and to arrange the best possible programs.

5.1.1 Annual Programs

The themes for annual programs for the next four years have been set. The programs are in various stages of planning.

2004–2005: Mathematics of Materials and Macromolecules: Multiple Scales, Disorder, and Singularities. The upcoming annual program continues a thematic thread of material science at the IMA. As highlighted in a 1999 NRC report, “the IMA recognized early that materials science, a critical technology area for the nation, also represented an important opportunity for the mathematical sciences. The IMA helped build a mathematical research community in this area more than five times the size of the community 10 years earlier.” The current program is aimed at a synthesis of the problems at the interface between mathematics, materials science, condensed matter physics, and biology, taking advantage of the fact that traditional barriers between the fields mentioned above are slowly disintegrating, providing rich interdisciplinary opportunities for the interplay between mathematics and the more traditional disciplines which have involved the study of matter.

We have assembled an organizing committee with diverse expertise for this program: Maria Carme T. Calderer (Minnesota), Richard D. James (Minnesota), Robert V. Kohn (NYU), Mitchell Luskin (Minnesota), John H. Maddocks (Lausanne), Rob Phillips (Caltech), James P. Sethna (Cornell), and Chris Wolverton (Ford).

Based on the nature of the scientific challenges in this area and the organizers analysis on how to best confront them, the program will have more long-term and fewer short-term visitors than typical. The long-term visitors and postdocs will be mostly organized into focused research groups, meeting regularly to study a particular physical or biological system, starting from known results and progressing to research projects. The major planned focus groups are


2. Singularities, Organizers: Fanghua Lin (NYU), Chun Liu (Pennsylvania State University), P. Sternberg (Indiana University).


4. Molecular Biomechanics, Organizers: John Maddocks (EPFL, Lausanne, Switzerland), Christof Schütte (Free University of Berlin, Germany).

The program will also feature eight workshops and a symposium:


3. IMA Symposium: Prospects for Mathematics and Mechanics upon the 80th Birthday of Jerry Ericksen, 5–6 November 2004, Organizers: Millard F. Beatty (University of Nebraska at Lincoln), Yi-chao Chen (University of Houston), Richard D. James (University of Minnesota), Mitchell Luskin (University of Minnesota).


7. Effective Theories for Materials and Macromolecules, 8–11 June 2005, Organizers: Weinan E (Princeton University), Richard D. James (University of Minnesota), Robert V. Kohn (Courant Institute), Claude Le Bris (Ecole Nationale des Ponts et Chaussées), Mitchell Luskin (University of Minnesota).

The following tutorials and short courses will be offered during the annual program.


2. Composites: Where Mathematics Meets Industry, 7-9 February 2005, Organizer: Graeme Walter Milton (University of Utah). Tutorial Lecturers: M. Gregory Forest (University of North Carolina at Chapel Hill), Graeme Walter Milton (University of Utah), Ping Sheng (Hong Kong University of Science and Technology). This is a combination tutorial and workshop.


The three day events in February and March were developed in conjunction with IMA’s industrial partners and aim to speed the transfer of contemporary mathematical advances to industry and to provide a forum for industrial researchers to explain relevant problems from their work.

The emphasis on long-term visitors has been implemented very effectively. We have commitments for stays of one month or more from nearly 100 scientists (not including the IMA postdocs), including over 40 committed for more than three months. We estimate that the resident community
will comprise about 50 people at any given moment. These include many scientific leaders, such as Pamela Cook (4 months), Masao Doi (4), Shi Jin (6), David Kinderlehrer (3), Benedict Leimkuhler (5), Fanghua Lin (4), Chun Liu (9), Christof Schütte (4), Peter Sternberg (10), Baisheng Yan (9), and Aaron Yip (5), in addition to the full year participation of Maria-Carme Calderer, Mitchell Luskin, and Richard James, Minnesota faculty and program organizers who have been fully released from teaching during the program. The resident community will include as well 11 postdocs: first year postdocs Brian DiDonna (U. Chicago PhD 2001), Sookyung Joo (Purdue 2004), Richard Kollar (U. Maryland 2004), Matthias Kurzke (Max Planck Institute 2004), Frederic Legoll (Paris VI 2004), and Xiantao Li (U. Wisconsin 2002); second year postdocs Gerard Awanou (U. Georgia 2003), Tim Garoni (Melbourne 2003), and Lea Popovic (Berkeley 2003); and industrial postdocs to be in residence Chiu Yen Kao (UCLA 2004) and Peter Philip (Humboldt U. 2003).

In 2004–2005, the IMA will host three New Directions Visiting Professors: Zhi-Qiang Wang (Utah State University) will be at the IMA in the fall and Shi Jin (University of Wisconsin) in the spring. Baisheng Yan (Michigan State University) will attend the full year. All three will spend their time at the IMA immersed in the annual thematic program.

**2005-2006: Imaging.** The proposal for this program has been approved by the Board of Governors. The organizers for the program are: Margaret Cheney (Rensselaer Polytechnic Institute), Don Geman (Johns Hopkins), Alberto Grunbaum (UC Berkeley), Dennis Healy (University of Maryland), Jan Koenderink (University of Utrecht), Frank Natterer (Münster), George Papanicolaou (Stanford). This year is divided into two semesters: Sensor to Images (in fall) and Images to Understanding (in spring). An outline of the program is available on the IMA web page.

**2006-2007: Applications of Algebraic Geometry.** The proposal for this program has been approved by the Board of Governors. The organizers for the program are: Dimitris Bertsimas (MIT), Pablo A. Parrilo (Swiss Federal Institute of Technology), Michael Stillman (Cornell University), Bernd Sturmfels (University of California at Berkeley), Madhu Sudan (MIT), Rekha Thomas (University of Washington).

### 5.1.2 Public Lectures

Each year the IMA organizes a small number of public lectures designed to engage the interested educated public, ranging from high school students to faculty. The purpose of the talks is to inform people about contemporary mathematics as it is applied to important technological and scientific problems, and convey some of the significance and excitement in this enterprise.

An exciting public lecture program is being developed for 2004–2005.

### 5.1.3 Summer Programs

**2005: Wireless Communication**, June 20–July 1, 2005. The organizers for this program are: George Yin (Wayne State), Prathima Agrawal (Auburn), Matthew Andrews (Bell Labs), Lisa Zhang (Bell Labs) and Phil Fleming (Motorola). This program builds on a very successful Hot Topics workshop on Wireless Networks which ran in 2001 and on several activities at the IMA and elsewhere on the mathematical modeling of communication networks. It will bring together researchers in mathematics, electrical engineering, computer science, and operations research, and industrial scientists.
working on wireless communication, to review recent advances and to identify research opportunities. A 3-day tutorial aimed at graduate students and postdocs will take place at the start of the program.

5.1.4 Hot Topics and Special Workshops

Hot topics and special workshops are usually organized quickly to take advantage of special opportunities. They are often organized in partnership with another interested organization. The following workshops are currently being planned.

1. *Mixed-Integer Programming*, 25–29 July 2005. Organizers: Alper Atamturk (University of California at Berkeley), Daniel Bienstock (Columbia University), Sanjeeb Dash (IBM - Research), Adam Letchford (Lancaster University of Management School) Jeffrey Linderoth (Lehigh University). This meeting will bring together many of the leading researchers in both the theoretical and computational aspects of MIP to highlight recent advances, foster interaction and collaboration, and to discuss how to expand the role of MIP in several potential high-impact application areas, such as network design for the Power Grid, and applications to computational biology and cryptography.


5.1.5 Programs for Graduate Students

*Mathematical Modeling*: The 2004 Mathematical Modeling in Industry workshop will take place from August 9 to August 18. In these workshops, the IMA recruits 6 industry scientists who act as mentors to 6 teams of graduate students. The mentors pose problems of interest to their companies, and supervises the students as they work towards their solutions. The main organizers for these events are Fadil Santosa and Fernando Reitich. The problems and mentors for this year are:


**Team 3.** Mentor: Thomas Grandine (Boeing). Topic: Shape comparison for free-form geometric modeling.


**Team 5.** Mentor: Julio Spinelli (Guidant Corporation). Topic: Governing mathematical model for piezoelectric transducer.

**Team 6.** Mentor: Steven Vestal (Honeywell Laboratories). Topic: Embedded real-time safety-critical computer and communication systems.
All except for Julio Spinelli are from IMA Participating Corporations.

**PI graduate student summer program:**
The PI graduate student summer program for 2005 will be chosen at the July 2004 meeting of the Participating Institutions Council from proposals received by the IMA.

### 5.1.6 PI Conferences

A listing of IMA Participating Institute conferences selected for the academic year 2004-2005 follows.


5. *The Sixth Mississippi State Conference on Differential Equations and Computational Simulations*, Mississippi State University, May, 2005 Organizers: Tunkay Aktosun and Ratnasingham Shivaji (Mississippi State University)


### 5.1.7 Postdoctoral Program

For the IMA 2004–2005 annual program, the following postdocs will be in residence at the IMA. The hiring committee consisted of Don Aronson, Carme Calderer, Richard James, John Maddocks, Fadil Santosa and Peter Sternberg.

<table>
<thead>
<tr>
<th>Name</th>
<th>PhD</th>
<th>Department</th>
</tr>
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<tbody>
<tr>
<td>Brian DiDonna</td>
<td>University of Chicago</td>
<td>Physics</td>
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<tr>
<td>Sookyung Joo</td>
<td>Purdue University</td>
<td>Mathematics</td>
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<tr>
<td>Richard Kollár</td>
<td>University of Maryland</td>
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<tr>
<td>Matthias Kurzke</td>
<td>University of Leipzig</td>
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<td>Frédéric Legoll</td>
<td>École nationale des Ponts &amp; Chaussées</td>
<td>Applied Mathematics</td>
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<tr>
<td>Xiantao Li</td>
<td>University of Wisconsin</td>
<td>Mathematics</td>
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</table>
Newly appointed IMA postdocs for the materials science year.

Returning second year postdocs, many of whom will be involved in the materials science program, are Gerard Awanou, Tim Garoni and Lea Popovic. See Section 3.10.1 for more details of their activities.

5.2 Outreach

It is in the mission of the IMA to engage scientists from underrepresented groups in its activities. Towards this goal, the IMA is collaborating with two groups, the Association for Women Mathematicians, and the Educational and Economic Development Partnership. Each group is represented by a committee whom the IMA consults on a regular basis. The groups form conduits through which we can increase the flow of mathematical scientists into the IMA programs, and thus, to connect them with the greater communities of researchers.

5.2.1 Human Resources Committees

The IMA uses two ad hoc committees in its efforts to increase the participation in IMA programs by women and minorities, and to provide career development workshops targeted to these groups. The IMA regularly consults with a committee developed with the Association for Women in Mathematics (currently consisting of Suzanne Brenner, chair, Fern Hunt, Pamela Cook, and Joan Feigenbaum) and a committee which grew out of the Joint Alliance for Minority Mathematicians, currently consisting of Raymond Johnson, Juan Meza, and James Turner, all former members of the IMA Board of Governors. The committee members are kept informed about upcoming programs at the IMA and suggest names of women and minority mathematicians potential interested in the programs. Each committee meets, generally through a conference call with preliminary and follow-up email, at least once a year.

5.2.2 Career Development Workshops

The IMA organizes workshops on career issues for women and minority mathematicians. The workshops serve to inform young mathematical scientists, many of them graduate students, about career opportunities in industry and national laboratories, and provides an occasion to make connections with established mathematicians at these sectors. During the workshops, participants have ample opportunity to discuss relevant issues with peers and senior mentors, and to develop lasting connections. Four such workshops have taken place at the IMA:

- Women in Mathematical Sciences Connected to Industry, 23–26 February 1996.
- Connecting Women in Mathematical Sciences to Industry 8–10 September 2000.

The IMA is planning to hold two similar workshops in 2005.

The IMA has been actively tracking the participants of the last two workshops. We found that many of the graduate students who attended have now obtained their PhD degrees, and have begun...
careers as professional mathematicians. After discussions with them and with senior participants of the previous workshops, we decided that there will be a new emphasis on early faculty career issues, such as tenure dossier development, in the future programs supporting these communities.

Many participants credit their participation with making a large impact in their career. Dorothy Buck, a graduate student at the time of the 2000 workshop and now a faculty member in applied mathematics at Brown University wrote: “I found the workshop very helpful... The most useful parts were the very specific (and candid) pieces of advice more senior women gave... especially concerning 2-body issues and job talks, and the discussions about how to transition into industry—something that no one in my department had experience with. I also really appreciated that it was all women there.” Mireille Boutin, who is now discussing returning as a long-term visitor during the algebraic geometry program in 2006–2007, reports that she is still in close contact with some of the women she met at the workshop. John Sanders was a participant in the 2001 minority workshop. He wrote that “the workshop’s impact on me may be described as a tidal wave,” and spoke of it as a source of inspiration, contacts, moral support, and practical suggestions. The IMA has also gotten in contact with the senior participants of these workshops and sought their advice and ideas to plan the next set of events. The pool of successful alumni from previous programs are a major resource the IMA will draw on in developing the upcoming workshops.

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I really enjoyed the “Minorities and Applied Mathematics—Connections to Industry and Government Laboratories” workshop that was held at the IMA in May 2001. It gave me an opportunity to network with minority mathematicians throughout the nation and connect the science to industry. I was also exposed to the wonderful opportunities at IMA which led to my IMA participation this spring.
– Narryn Fisher, University of Maryland

I found the workshop very valuable. In fact with the help of the information I learned there, I was able to interview with and get a job offer from Aerospace Corporation after my PhD. I chose instead to do an NSF postdoc abroad in France but am still in touch with my contacts at Aerospace who would also most likely have offered me a job after my postdoc was finished... In more general terms I think the workshop helped break down barriers between industry and academia and taught us to communicate with each other in a more efficient way.
– Catherine Lebiedzik, Wayne State University

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5.2.3 Director Visits to Academic Institution, Government Labs and Industry

During the reporting period, the IMA Directors visited a number of organizations for the purpose of disseminating the IMA message, encouraging participation in IMA activities, and for soliciting ideas for future programs. Most visits last a full day and involve presentations by the IMA directors and numerous face-to-face meeting. Academic institutions visited include Georgia Tech, IAC-CNR (Rome), McGill University, Notre Dame, Rice University, Texas A&M University and University of Michigan. Corporations visited were Boeing, Corning, Ford, GM, Honeywell, Medtronic, and Transoma.
5.3 The IMA and the World Wide Web

The IMA uses its website as the chief mechanism for organizing, disseminating, and archiving information from IMA programs and about the IMA. The IMA web server experiences averages of about 53,000 hits per day, or 20,000,000 per year.

Current and Upcoming Program Information. The IMA homepage, www.ima.umn.edu, provides links to the website for the current annual program, as well as all approved future programs. This means that program information is available for about three years in advance. It also links to our current and upcoming summer programs, to hot topics workshops, to IMA related seminars and to upcoming public lectures. For information about current and future activities, we provide a “What’s Happening Now” link from our main sidebar, connecting to a page that, in turn, links to the daily and weekly schedules, to the monthly IMA newsletter and to the websites describing the current quarter’s activities and the current year’s activities.

The IMA Website and IMA Publications. We provide a “Preprint/Publications” page, linked from our main sidebar, from which one may download a variety of IMA publications including the monthly IMA newsletter and the quarterly IMA “Update” publication. The newsletter will soon join the Update as a all-electronic publication—we are in the process of converting hardcopy subscriptions of the newsletter to electronic. Also available from the preprint/publications page is the IMA preprint series. Finally, for select topics, the IMA publishes books in its IMA Volume series, also accessible from the preprints/publication website. Interested parties may sign up to receive electronic notification and/or mailing of our regular publications, via the IMA Mailing Lists website, www.ima.umn.edu/lists/.

The IMA Website as an Archive. We archive almost all information that appears on our website, including

- webpages describing each annual theme,
- webpages describing each quarter, and
- webpages describing each individual workshop, short course, tutorial and summer program.

We make a great effort to store materials related to talks given at the IMA on our website. Abstracts, titles and slides (either electronically submitted or scanned) are put on our website, and these materials are linked from a number of places, including the workshop schedule for the workshop at which the talk was given. Except for the small number of speakers who object, talks given at the IMA are made available to the world permanently. In addition, video and audio recordings are available for selected events such as public lectures and Industrial Problems Seminars.

Happy that the slides and other materials have been posted now, so that I can review the material, and share with others. – Robert B. Feinberg, NSA

Visitor Information. The IMA’s Visitor and Local Information web pages contain answers to the most frequently asked questions visitors have about arrangements with the IMA. It is linked from the main sidebar and has information on a wide range of topics including:
• Reimbursement policies
• Computer system information
• Housing information
• Visa information
• General visitor information (e.g., local dining, transportation, long-distance calling, security, etc.)
• Maps
• Photo gallery

Program Solicitation. The website is one means of encouraging members of the mathematical sciences community to suggest future programs at all levels, from annual themes to summer programs to individual workshops. The “Program Solicitation” link on the IMA sidebar describes the procedures and just what is involved.

The Web-oriented IMA Database. In 2003, after a major in-house development effort, the IMA deployed a new database for managing its visitor data. The system, called Discovery, is a sophisticated relational database with an advanced web-based management interface. Its design, by IMA systems programmer Peter Lawrence, uses 49 tables of up to 36 columns each to reflect the complex, dynamic, inter-related data that the IMA needs in order to track, serve, and follow-up with visitors and organizers. Discovery has been built completely from open source/open license software, using PostgreSQL as the relational database engine and PHP and other web technology for the interface.

All IMA visitor data since 1990 has been ported to Discovery, so that at present it contains records of 14,726 distinct visitors from more than 3,500 organizations, and 21,418 visits to the IMA for more than 450 IMA events.

Discovery has streamlined many IMA operations, and serves many functions within the IMA, including:
• Keeping track of visitors, visits, events, organizations, even when visitors change organizations between visits, temporarily or permanently.
• Producing hardcopy items such as mailing labels, door and folder labels, and nametags.
• Generating email such as invitation reminders, feedback requests, and registration lists.
• Automatic generation of public and password protected web code, such as participant lists for workshop web pages and invitation status reports for organizers.
• Highly flexible reporting which can be used by staff and directors for tracking, planning, reporting, and financial management.
• Automatic generation of reports and reminders for staff when circumstances require their attention.

Building on the successful development of Discovery, the IMA is presently developing a coordinated database application that will track IMA events and schedules to the level of individual talks, titles, abstracts, and archival material. When completed in late 2004, this database will greatly simplify the production of workshop schedules, both hardcopy and web, newsletters and other publications, and online dissemination mechanisms, while improving their accuracy, appearance, and flexibility.

Feedback and Surveys. The web is a powerful tool in our constant efforts to assess and improve our performance. We solicit feedback from all IMA participants, and because of the easy web form, we have a high response rate and we receive information that is relatively easy to digest. To assess longer term impacts we have recently developed web survey forms as well.
Membership Applications and Registration. The IMA offers a variety of participation opportunities. The IMA sidebar contains a link for “Program Registration” by which interested parties can request an invitation to an IMA program, and, if desired, request to be considered for funding. The major visiting possibilities, besides those initiated by IMA invitation, are:

- IMA General membership (one month to a year)
- IMA Postdoc
- IMA Industrial Postdoc
- IMA New Directions Visiting Professor
- IMA New Directions Short Course

Descriptions and application forms and procedures for these opportunities are on the web, and advertising refers to the web site.